Environmental Design Strategies to Mitigate Stress in the Workplace.

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Abstract:

An issue that affects every occupants' health and well-being, significantly and vastly, is stress. The negative effects of stress are more impactful in workplaces; with stress acting as an agent of disease and as an obstacle to employee productivity and satisfaction. Although the causes of occupational stress are varied, the built environment can be one of the critical sources of it. In other words, the occupational stress might have various sources and designers only have control over design. The designer can employ a group of interventions to mitigate occupational stress. In this research, we call those design strategies environmental interventions. The literature on occupant health, well-being, satisfaction, and productivity are broad and multifaceted; however, in this research is limited to stress factors that correlated with the built environment and focus on employees who are experiencing a high rate of stress in office buildings as the target group. As such, the researcher finds evidence of environmental interventions that can reduce stress or enhance stress coping abilities of workers in offices by improving environmental health. The questions that this research is answering are; what are the main environmental factors in offices that can help lower stress levels of employees, or help them to recover more easily from workplace stress? How can space cause people stress? How does built environment magnify stress? In order to answer those questions, it is necessary to understand the chronic stress and work-related stressors and identify the factors in the built environment that can associate with occupational stress. This research is based on the cross-disciplinarily systematic literature review of architecture, planning, public health, medical, neuroscience, management and psychological sciences, in the form of Meta-analyze. The outcome of this research is a set of strategies that provide solutions for healthier and productive working places in offices with a concentration on the reduction of the stress level of employees, which can be used in as a source for workplace evidence-based designs. These strategies are discussed in three realms; urban, architecture and conjunction area as a mediator between outside and inside.

Keywords: Suitable design, built environment, public health, occupational stress, office, working places, evidence-based design, Therapeutic.
1. Introduction:
Public health is a growing multidisciplinary field with many aspects such as social, economic, medical and environmental. The built environment can have significant effects on its users, and their health and wellbeing. Although public health has not traditionally been the core concern of architecture studies, today this is changing; the architecture profession now values the overall health and well-being more and consider it a crucial part of sustainable design. Besides that, another important change is a huge shift from manufacturing sector to the services sector, and knowledge-based industry (Al Horr et al., 2016). In addition to that, workers spend most of their time in the indoor environment (Al Horr et al., 2016).

Health and wellbeing of workers are now critical for the corporation, which demands healthier approaches in design as a client; because the staff counts as a most valuable resource in organizations. Due to the importance of the satisfaction of employees for productivity and their wellbeing, providing satisfying environmental is a crucial component for resource optimization. As the concerns of this research, various environmental factors associated with employees satisfaction (Frontczak et al., 2012) that would be discussed further. In addition, people are now facing more stress due to the fast-paced of urban lifestyle and work demands. Despite the fact that cities now provide better healthcare facilities, they expose more people to environmental and social risk factors that cause stress ((Gruebner et al., 2017), which is a risk factor for many diseases. Accordingly, today, the occupational health is becoming, indisputably, major design concern.

Not all challenges in the workplace qualify as job stress. Work challenges can possibly present positive effects and help personal growth (Wright, 2007). Job stress happens when an individual loses his or her control on employment demands (Wright, 2007). In this approach, occupational stress is considered the agent and built environment as a vector and risk factor for causing diseases. The negative impacts of stress are not limited to mental health problems but are also considered a source for many medical health problems such as diabetes, high pressure, and weight issues (Adli, 2011).

Accordingly, designers now facing the challenge of mitigating stress in workplaces in an ever-growing stressful environment. The critical questions that should be answered for healthier workplaces are; what are the main environmental factors in offices that can help the employees experience lower stress levels and, what elemental factors can help them to recover from the stress after facing it?

In this paper, the author discusses how the built environment affects the workplace and identifies design interventions that help reduce employees’ stress levels. The target population in this research are highly stressed employees and those facing chronical stresses in daily bases in offices, in order to improve welling of them by environmental evidence base design. The vision of this research is to draw pictures of healthier and
happier working environments that help each employee to function more easily, thus to better prosper in his or her career. Also, by means of that reaching to improving social aspects of design for better life quality. To do so, reducing stress or enhancing personal moods to recover in offices by design and environmental improvement of the workplace is chosen as a mission of this review. The outcome of this meta-analysis is set of practical architectural strategies.

2. Literature review:
The author employs cross-disciplinary systematic literature review in order to translate a public health issue to the language of architecture and discuss the possible design intervention with the lens of public health. For decades, stress was a topic in many fields of science, such as public health, neuroscience, psychology, healthcare, social sciences, environmental studies, urban studies, planning, medical sciences, and management. Although a considerable amount of researcher has been done about occupational stress, the built environment as an essential player was not studied, or the approach is vague, making it difficult to draw firm conclusions out of them. The relationship between environmental factors and employees productivity and wellbeing can be traced back to 1920 (Al Horr et al., 2016), but the body of research about the relation between the built environment and occupational stress is relatively insignificant and not up to date. On the other hand, public health issues in architecture are recently emerging and receiving more attention.

Most researchers in this field are focusing on the general wellbeing of the users, which includes many aspects such as; productivity, satisfaction and mental health of workers. The aim of this research is to discover the relationship between occupational stress and built environment in the workplace through systematic cross-disciplinary literature review in the various fields. In addition to classification of possible strategies for intervention in offices for reducing occupation stress, this research sheds light on the areas without enough information that requires doing further research, experiments, and primary studies on them.

After comprehensive bibliographical data search, 210 of those were selected for abstract screening and 106 were cited in this paper. Although different data sources in used for this research, in the public health field, the primary data source that I used was PubMed’s database. The keywords that the author was looking for were “stress and built environment” and “stress at workplace,” “Stress, Psychological,” “occupational stress,” “workplace,” and “employment.” For built environment section, the searches have been done in Web of Science, Google Scholar, and Research Gate. In addition, part of the data is conducted by observation and documentation.
Diagram 1: Literature research map
2.1. The significance of the problem of chronic stress in Personal Level:

World Health Organization (WHO) defined the term “occupational risk factor” as “a chemical, physical, biological or any another agent that may cause harm to an exposed person in the workplace and is potentially modifiable (“WHO | Chapter 21,” n.d.).” Stress affects how a person performs (behaviors), how a person feels (emotions), and what physical responses (neurophysiological) (Figueroa-Fankhanel, 2014). According to those facts, stress is one of the occupational risk factors. In addition, the main occupational risks that cause of death are “unintentional injuries, chronic obstructive pulmonary disease (COPD) and cancer (Li et al., 2015).” COPD almost responsible for 40% (Li et al., 2015) occupational risk factor and it is directly related to stress. The associations of coronary heart disease with work-related stress in industrialized countries is well studied (“WHO | Chapter 4,” n.d.), and probably the challenges and problems would be the same in developing countries as well. These work-related stressors are high due to the “psychological demands and low decision-making latitude among white-collar occupations including managers, administrators, supervisors, and proprietors (“WHO | Chapter 4,” n.d.).”

Chronic stressors are associated with the destruction of both cellular and humoral procedures (Segerstrom and Miller, 2004). When a person is stressed, naturally the adrenaline, cortisol, and norepinephrine hormones in his or her blood will increase. Those physical responses are the natural way that our body reacts to the environmental threat, but if someone gets exposed to the long-term stress, chronic stress, the adverse effects of this constant high level of aforementioned hormones will lead to severe diseases (Figueroa-Fankhanel, 2014). For instance, cortisol, can harm many organs at the cellular level and reduce immunity (Segerstrom and Miller, 2004). When stress continues extensively, it will contribute to distress; a state of physical or mental pain and suffering (Figueroa-Fankhanel, 2014). “Distress is the unhealthy consequence of occupational stress and may result from prolonged, frequent, or intense stress exposure (Quick and Henderson, 2016).” Distress can be classified into three categories; medical, psychological, or behavioral (Quick and Henderson, 2016).
2.1.1. Medical Distress:

Medical distress cause heart disease, cancers, and musculoskeletal injuries with their related pain and disability (Quick and Henderson, 2016). Job stress has been known as an important factor in cardiovascular disease (Quick and Henderson, 2016). In fact, "stress is implicated in the prognosis of cardiovascular disease and the development of stress cardiomyopathy. For some, the researchers stress processes count as a major challenge of cardiovascular pathophysiological research and understanding, over the next decade (Steptoe and Kivimäki, 2013)."

Moreover, some recent research shows stress as an important factor for the beginning of cancers and has a secondary role in worsening the disease and recovery (Quick and Henderson, 2016). Although considerable number studies confirm that stress is one of the agents that associate with cancer (Moreno-Smith et al., 2010; Shin et al., 2016), some still believe there is not an association between common cancers or chronic obstructive pulmonary disease and stress (Kivimäki and Kawachi, 2015). Some research even suggests that job stress increases the risk for development of musculoskeletal disorders (Wright, 2007).

Also, "Meta-analyses of a wider range of health outcomes show that there is an association between work stress and type 2 diabetes (Kivimäki and Kawachi, 2015)."

The occupational stress effects would be similar to those of secondhand smoke (Welker, 2016). Even many research’s findings confirm that psychological stress, perceived stress, and chronical stress, would accelerate aging. “Psychological stress associated with oxidative stress and this would shorten telomere length, and reduce the life cycle..."
of cells and promote earlier age-related diseases (Epel et al., 2004; von Zglinicki, 2002).” The following passage explains this distress’s process well:

“Noradrenaline and adrenaline increase the heart rate and decrease the heart rate variability, dilate the respiratory airways and activate blood platelets to coagulate (Adli, 2011).

Cortisol antagonizes insulin and thus…results in a diabetes-like metabolic situation. It restricts body fat, promotes obesity, suppresses the immune system and may have a toxic effect on neurons in certain brain regions, particularly the hippocampus, which is important for memory functions. Repeated exposure to social stress in rats leads to abnormal processing…that plays an important role in the development of Alzheimer’s disease (Adli, 2011).”

Diagram 3: The Relation of The Host, agent, and disease

2.1.2. Psychological Distress:

Quality of Life (QoL) of people’s is directly related to their quality of work life (QWL) (Fleury-Bahi et al., 2017). The Quality of life affects people on a personal level and depends on individual situation and expectation. Quality of life is the synergy of cumulative life experiences, which built environment is of the domains of life experience (Fleury-Bahi et al., 2017). Well-being and happiness would be both cause
and product of high-level Quality of life (Fleury-Bahi et al., 2017). Quality of Work life is one aspect of Quality of Life that is related to work. It is important to not mix Quality of work life with work satisfaction. Work satisfaction is just part of Quality of Work life. QWL is trying to address multidimensional emotional needs of workers with their work with considering their personal set of values and needs, which work built environment is one of them. “A Poor QWL often means increased stress at work (Fleury-Bahi et al., 2017)” and stress is a significant player that affects the mental health and well-being of the people.

The psychological suffering or pain would be fundamental to many of physical and behavioral distresses (Quick and Henderson, 2016), and stress is an agent for them. Anxiety and depression are the two primary common disorders that associated with stress. “Epidemiological research found a significantly high (nearly 10%) occurrence of mood and anxiety disorders within the U.S. population (Quick and Henderson, 2016).”

2.1.3. Behavioral Distress:

One of the America’s top social problems is drug abuse. “Exposure to stress is one of the most powerful triggers of substance abuse in vulnerable individuals and in former addicts (NIDA, n.d.).” “The leading forms of behavioral distress include tobacco abuse, alcohol and drug abuse, aggression, and violence, and accidents. The direct costs of smoking were reached at $96 billion from 2001 to 2004 with an additional equivalent cost of lost productivity and increased health care expenses (Quick and Henderson, 2016).”

2.2. The significance of the problem of occupational stress on organizations level:

One of the most important settings for mental health advancement is workplace (Czabała et al., 2011). The North American workers spend at least 50% of their indoor time in the workplace; thus work environment would have a significant impact on the employees (Fleury-Bahi et al., 2017). Stress not only affects employees on a personal level but also occupational stress and work-related mental health problems would have adverse socio-economic effects on the organization through disability, absenteeism, labor turnover and reduction in productivity (Czabała et al., 2011; Palmer and Dryden, 1994). In many corporations, 90% of operating costs are related to the staff (WGBC, 2016). U.S. Bureau of Labor Statistics (BLS), in 2017, reported that wages and salaries make up about 70 percent, and benefits make up the 30 percent of compensation (U.S. Bureau of Labor Statistics, 2017). Thus, by improving even 1% staff’s productivity can have a considerable impact on bottom line and competitiveness of any business (WGBC, 2016). BLS reported that workers’ stress can be the cause of 23 days off the job in the median in 1997, which was four times more than median absence for all occupational injuries.
and illnesses (U.S. Bureau of Labor Statistics, 1999a)." The BLS also classified four industries with the most of occupational stress work away cases: 1-services, 2-manufacturing, 3-retail trade and 4-finance and insurance and real estate(U.S. Bureau of Labor Statistics, 1999b). In 1997, more than one-third of days away from work is related to stress in the service sector; in comparison, only less than one-fourth of the day away from work was related to none fatal occupational injuries and illnesses(U.S. Bureau of Labor Statistics, 1999b).

There are three theoretical main models for studying the relation of productivity and environment in the organizations; 1- User Satisfaction Model, 2- Employee Motivation Model, 3- Adaptation and Stress Model (Vischer, 2003). User Satisfaction model the most employed one that focuses on the perception of individuals and whether they like or dislike the working environment. Employee Motivation model’s outlines are based on sociologist Frederick Herzberg (Herzberg, 1966) which discuss the environmental and behavioral factors that influence on workers’ motivation, mostly in individual level (Vischer, 2003). Adaptation and Stress model is considering adaptation behavior and stress as measures for productivity (Vischer, 2003), which would be discussed further.

2.2.1. Measurement of stress and proxies:

One of the challenges of studying the occupational stress’s effects on the organizations is finding the correct and reliable measurement of stress and proxies that indicate the level stress of employees. In fact, many of disagreement on this topics and contradiction outcomes of different researches, especially in epidemiology, is because of choosing different measurement and proxies. Even in experimental research on medical distresses, in similar condition, a study would have different outcome base on the chosen measurement; for instance, measuring cortisol in blood test versus saliva test would have a different result. To avoid this biases in research it is important that the measurement and proxies be chosen carefully base one the goals and context.

To understand the correlation between stress and organization performance, researchers need to measure the byproduct of that which could be used as a measure for studying the occupational stress. Also, there are different definitions for a term of stress based on the theory that informs the approach was taken(Palmer and Dryden, 1994), that makes it even more complicated. Choosing the measurements is directly related to aims of the research approach to occupational stress. In physiology realm; aim mostly is about improving Quality of Life(QoL) through Quality of Work life (QWL) and Environmental Quality (EQ). In business and management studies; the main aim is about the improvement of productivity, effectiveness, absenteeism reduction and satisfaction. On the other hand, in public health realm, the main issue would be an improvement of the general health of the target group which is workers to cope with stress and reduce it and have mental and medical aspects.
Each measurement is studying a series of proxies related to the aim of the research. In public health, it could be varied from experimental examination on cell and hormonal level to self-reports on mental health conditions. In psychological realm, self-report questionnaires, rating scales or psychometric instruments, life data and physiologic could be the measures. Also, functional comfort could be a measurement of the Environment Quality (EQ), since a functionally uncomfortable environment can causes workspace stress and reduces Quality of Work Life. (Vischer and Wifi, 2017).

In management and business studies, proxies are a day away from work and effectiveness which are important issues in any organization. The US Bureau of Labor Statistics classified cases of “occupational stress involving days away from work are classified as cases of Neurotic Reaction to Stress(U.S. Bureau of Labor Statistics, 1999a)”, which shows how this measure is related to a physiological approach to occupational stress.

In a reliable systematic review which is done by Czabala and et al in 2011, different approaches to researches on workplace promotion have been studied. They studied 76 high-quality research related to the workplace mental health promotion and claimed that most researchers aim was reducing stress and better coping with it(Czabala et al., 2011). Also, they stated that job effectiveness and reduction in absenteeism related to mental health problems are indirect results of effective mental health promotion(Czabala et al., 2011). Some of the reliable measurements they find in physiological studies are; 1- Maslach Burnout Inventory (MBI), 2-the General Health Questionnaire (GHQ), 3- the Mean Absenteeism Figures, and 3- the State-Trait Anxiety Inventory (STAI). They claim that self-reporting is not a reliable measurement in stress studies(Czabala et al., 2011). It seems, to avoid biases, it is better to use multiple measurements.

Jacqueline C. Vischer classified the measurement for productivity based on the systematic review she did on productivity researches. Two main categories can be identified in the researches with the aim to improve the productivity; 1- Indivual Task Performance (ITP) productivity and 2-Collaborative and Teamwork (CTW) productivity(Vischer, 2003). A group of measurements for the individual category are; Faster, more accurate output; absenteeism and illness; employee recruitment and employee turnover and reduced retention(Vischer, 2003). Measurement group category (CTW) includes; Error rate; shrinking group size; lower costs; better decisions and customer complaints(Vischer, 2003).

2.3. Epidemiology

During the literature review, the author finds many contradictory results, especially in related epidemiology studies. In some of the research, there is no difference in the effect of stress on people with the various social determinants; on the other hand, other
research found the significant differences in the response of each individual to the chronic stress and suggested that the focus should be on just individuals’ demands(Vitić, 2014). These differences are getting more clear in age and genders’ target groups in different studies. Besides different contexts, a parameter that each study has chosen to test the level of stress varies the outcomes. For instance; in research by Kivimäki and Kawachi “differences between men and women, younger versus older employees and workers from different socioeconomic backgrounds appear to be small, indicating that the association is robust(Kivimäki and Kawachi, 2015).”

Aging as an important determinant in workplaces is getting more critical since the now median age for retirement is exceeded(Zsoldos et al., 2014). Zsoldos’ team find that There is a direct relation between getting older and occupational stress(Zsoldos et al., 2014). That study shows that by getting older, employees might get more vulnerable to stressors, and face more age-related diseases, and due to that take early retirement. Moreover, those older employees that their identity associated with a minority group, more likely to face bullying and discrimination, which are extreme stressors(Zsoldos et al., 2014).

However, some facts are applied to most of the target groups, and most of the research agree on it. Studies have shown that, in general, the risk for severe mental illness is higher in cities compared to rural areas(Gruebner et al., 2017). Also, stress at work in industrialized nations is associated with cardiovascular disease, and the risks will also exist in developing and industrializing countries in similar types of work (“WHO | Chapter 4,” n.d.). Another vulnerable group to distresses who face a high level of stress, are working classes, immigrants, seasonal workers, and blue-collar experience (Li et al., 2015), and that is related to the fact that they have less control over their environment(Aronsson, 1989). Another firm statement is that the white-collar worker is more affected by stress in comparison to the Blue collar workers(U.S. Bureau of Labor Statistics, 1999c; “WHO | Chapter 21,” n.d.). White-collar jobs are classified into two group: 1- managerial and professional occupations and 2- technical, sales, and administrative support occupations(U.S. Bureau of Labor Statistics, 1999c). Blue Collars are workers that their jobs are related to operators, fabricators, and laborers and precision production, craft, and repair(U.S. Bureau of Labor Statistics, 1999c). Among all of those, technical, sale and administrative support occupations are affected more by job stress(U.S. Bureau of Labor Statistics, 1999c); that also might relate to not having control on their work, relatively (Aronsson, 1989).

Studies involving women are too small to draw a firm conclusion about women work stress and health problem(Leka and Jain, 2010). In fact, the literature review showed that there are many contradictory results in studies exist. The finding of Beil and Hanes’ study that measured by pre-to-post changes in salivary amylase (an
enzyme) and self-reported stress shows differences were more significant for females than for males (Beil and Hanes, 2013). In contrast, the research done by Nielsen and colleagues found no associations between stress and mortality among women, even it stated that high stressed younger women are less vulnerable to cancer mortality (Nielsen et al., 2008). In that research, the young men are more at risk of stress-related cancer, even in comparison to older men (Nielsen et al., 2008). Thus, emphasis should be on the set of prevention strategies for those presumably healthy men who face stress, as a risk factor for premature death among middle-aged (Nielsen et al., 2008).

2.4. Risk factors and disparities:

Today, many adults spend 90 percent of their time indoor and considerable hours of that time is spent during working hours and in workplaces (Welker, 2016), thus understanding the related risk factors are crucial for urban occupants. Risk factors for occupational stress could be varied, but the following are primary issues; “restricted discretion, shift work (notably night shift), effort-reward imbalance, high demands, the poor psychosocial work environment, social isolation, physical inactivity and occupational violence (Leka and Jain, 2010)” and those risk factors are interconnected and interact with each other (Ezzati, 2004; Härnä et al., 2006; Smith and Beaton, 2008). Not all those risk factors would directly relate to the built environment. Among those social and psychological work environments are the elements that are more related to the concentration of this research.

In a study done by Quicks and colleague which is based on a systematic literature review, four broad categories of workplace demand that cause distresses are categorized; “1-task demands (occupation, careers, workload, job insecurity); 2-role demands (role conflict and ambiguity); 3-physical demands (temperature, lighting, workplace design); and 4-interpersonal demands (social density, personality conflicts, leadership style, group pressures) (Brown and Richerson, 2014; Quick and Henderson, 2016).” In those categories, physical demands and interpersonal demands are the categories that most of the risk factor that related to the built environment is related to them. Also, group intervention could relate to comfort can be classified to both task and physical demand. These demands can increase the risk factor of stress in the working environment. This classification defines the areas of interventions that this research is tried to address. Later in this study, we talk about more tactical sub-categories of this two demands.

2.5. Baseline theories of interventions related to occupational stresses:

Due to the people’s urban lifestyle, many people today are facing constant stress, which is partly related to the physical environment. Stress is considered as some of our
fundamental biological mechanism and behavioral archetypes, which are related to the natural history of people (Stevens, 1982) and evolution. The human behavior and evolutionary theory have been employed with different approaches in biology, psychology, and anthropology sciences (Brown and Richerson, 2014) and those have related subfields include “Human Behavioural Ecology, Evolutionary Psychology, and Cultural Evolution.” All of these approaches try to explain people’s contemporary behavior and environmental reactions.

Stress is the humans’ natural reaction to threats, and it causes several physiological concourses that function to save human life when threatened. Even in the absence of those natural threats; some environmental factor can simulate the same situation and same physiological consequences. As discussed, fundamentals of many of human’s physiological and psychological demands are related to evolution and humans’ common experiences and many of our today’s behavior and needs are shaped by humans’ evolution process (Gillis and Gatersleben, 2015). One of the primary needs of humans is needed to have access to nature, and there is the sufficient evidence that supports this theory that access to nature and greenery plays a significant role in the reduction of stress. Theories like Biophilia, Attention Restoration Theory (ART) and Stress Recovery Theory (SRT) (Gillis and Gatersleben, 2015; Kaplan and Kaplan, 1989; Ulrich, 1984) are trying to theorize the human wellbeing with this lens.

One of the critical related body of knowledge that discusses the relation of human behavior, psychology and wellbeing are those based on Biophilic theory. Ulrich in SRT theory predicts that natural scenes tend to reduce stress, and built environment has an adverse effect (Ulrich, 1984; Velarde et al., 2007). Kaplans in ART theory discusses the restorative effect of natural environments on human mental fatigue (Kaplan and Kaplan, 1989). The Restoration here refers to “the process of renewing physical, psychological and social capabilities diminished in ongoing efforts to meet adaptive demands (Kaplan and Kaplan, 1989; Velarde et al., 2007).”

In a similar approach; in the Environment of Evolutionary Adaptation (EEA) presumes that human adapted to nature through evolution. When “Mismatches; the situation that humans are not behaving or interacting in way genetically adapted to it,” happen, in some cases, would have an adverse impact and cause stress which is called “discord” (Grinde, 2002; Grinde and Patil, 2009). Therapeutic Landscape is another approach that discusses the relationship between health and nature (Velarde et al., 2007; Winterbottom and Wagenfeld, 2015). This theory connected the idea of the place identity and health and is rooted in cultural geography (Gesler, 2005).

Although nature has a positive affect human’s stress restoration process, the characteristic of it matters. Some natural setting like densely wooded areas might not have any restorative effect (Gatersleben and Andrews, 2013). The environment with restorative effects has high levels of prospect (open view and clear vision) and low levels of refuge (hiding); In contrast, The natural environment that with a low prospect
and great refuge level might even increase stress and attention fatigue (Gatersleben and Andrews, 2013). This is important for designing the general layout of any workplace. Adaptation and Stress theory is another approach to study the relation of stress and environment which mostly discussed in productivity studies. This theory states that an effective and supportive environmental design means users make adaptation to the environment within comfortable boundaries for workers. New Work Environments Research Group in University of Montreal (2000) developed the concept of comfort to expand this theory. They studied work comfort in physical, psychological and functional categories (Vischer, 2007). Physical comfort is about “health and safety; responsible design decisions; respecting construction standards, comfort standards which are mostly provided in modern buildings (Vischer, 2003).” Psychological comfort is considering “territoriality and privacy; satisfaction; environmental empowerment through information dissemination and choice (Vischer, 2003).” The third one, functional comfort is focusing on “workspace designed to support task performance, improved task performance, environmental competence; measurable dimensions (Vischer, 2003).” However, it seems that physical and functional comfort is almost addressing same needs like light comfort, temperature comfort or air quality and do not have clear boundaries. The only clear difference is that the physical comfort is mostly addressing general condition and habitability of building and functional comfort more focuses on individual tasks.

2.5.1. Biophilic Theory:

Biophilia is a new hypothesis that is now getting popular in building sciences; although, there is many similar hypothesis and thesis were issued a long time ago. Term biophilia was introduced by the social psychologist, Erich Fromm and it means love of life in Greek (Browning et al., 2012). It became part of the academic language in the 1980s by an American biologist, Edward O. Wilson (Browning et al., 2012) and later expanded by Stephan Kellert. Indeed, all species, including humans, have been shaped and evolved by the forces of evolution and nature (Gray and Birrell, 2014) (Browning et al., 2012). Biophilia is a hypothesis that discusses intrinsic inclination of humans to affiliate with nature (Grinde and Patil, 2009; Kellert, 1995). This affiliation with nature has neurological and physiological effects on the human (Browning et al., 2012). The human body’s autonomic nervous system has two fragments: the sympathetic (state of consciousness about the environment and threats) and the parasympathetic (state of relaxation and internal process) system (Browning et al., 2012). The human desirable state is achieved by a balance of this two systems, but our urban lifestyle put people in the sympathetic state (Browning et al., 2012). The Biophilia goal is to increase parasympathetic activity and reduce sympathetic activity (Browning et al., 2012).
Although many successful architects and planners like Ebenezer Howard, Frank Lloyd Wright and Le Corbusier in the recent modern history (Fishman, 2016) and many historical built environment design concepts such and central courtyards (Alhorr et al., 2015; Browning et al., 2012), Persian gardens and garden cities (Pour et al., 2012) and middle age European hospital's healing gardens (Velarde et al., 2007) are instinctively based on the relation between nature and human satisfaction, but the biophilic design tries to provide scientific evidence for design and provide sets of guidelines based on reliable research. Application of biophilic design is categorized by Kellert and Calabrese (2015) in three primary experiences; “1- Direct experience of nature, the 2- Indirect experience of nature and 3- experience of space and place (Kellert and Calabrese, 2015).” Table.1 is based on those experiences, and their 24 attributes that Kellert and Calabrese described. These experience and attributes are directly affiliated with mitigation of stress and general well-being of people.

Another categories are suggested for the biophilia implication that they almost have the same approach with three categories; 1- Nature in space, 2- Natural Analogues and 3- Spatial organization (Browning et al., 2012).

Biophilic design is stated as a design philosophy, based on biophilia hypothesis, that encourages the use of natural systems and processes (Gillis and Gatersleben, 2015; Kellert, 1995) in the design of the built environment. Although there are similarities between biophilic design and biomimicry (bionic) design, they are not parallel (Kellert, 2014). The biomimicry (bionic) is not necessarily trying to represent the nature and concentrate more on the final product, however, in biophilic design similarity to nature is directed to the human wellbeing (Kellert, 2014). The biophilic design also relates to sustainable design, but the biophilic design is not only limited to the reduction of human footprint and extended its arguments even to issues like biodiversity conservation (Baldwin et al., 2011; Kellert, 2008). However, its suggested physical intervention, such as using green walls, are associated with energy efficiency, green buildings’ guidelines and sustainability (Ganji et al., 2013).

To implement this design strategy, designers should consider the building occupants, location (context), and its function (Gillis and Gatersleben, 2015). Kellert discussed that biophilic design is not about the temporary or insolate experience since it would have just a superficial and brief effect on people (Kellert, 2015). The biophilic approach should be a comprehensive design. In another word, natural features should be considered in all aspect of design to have beneficial outcomes and effects on occupants (Kellert, 2015). He emphasized that the out of the contexts natural element or individual approach would not be an effective design (Kellert, 2015). He also brought up this argument that social interaction of occupant is one of the natural needs of them as social species and should be considered as biophilic design (Kellert, 2015).
Table 1: Experience and attributes of biophilic design by Kellert and Calaberese (2015)

<table>
<thead>
<tr>
<th>Application of Biophilic Design</th>
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</thead>
<tbody>
<tr>
<td><strong>direct experience of nature</strong></td>
</tr>
<tr>
<td>• Light</td>
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<tr>
<td>• Air</td>
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<tr>
<td>• Water</td>
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<td>• Plants</td>
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<td>• Animals</td>
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<tr>
<td>• Weather</td>
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<tr>
<td>• Natural landscapes and ecosystems</td>
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<tr>
<td>• Fire</td>
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<tr>
<td><strong>Experience of space and place</strong></td>
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<tr>
<td>• Prospect and refuge</td>
</tr>
<tr>
<td>• Organized complexity</td>
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<tr>
<td>• Transitional Spaces</td>
</tr>
<tr>
<td>• Cultural and ecological attachment to place</td>
</tr>
</tbody>
</table>

There is substantial evidence that biophilic design can “improve productivity, mitigate stress, enhance well-being, foster a collaborative work environment and promote workplace satisfaction (Gray and Birrell, 2014).” A review of psychology literature, done by Gillis and Gatersleben, also admits the positive effects of Biophilic design’s attribute on recovery from mental fatigue and stress (Gillis and Gatersleben, 2015). Gillis and Gatersleben evaluated the biophilia theory with the literature of two other environment-physiological theories; Attention Restoration Theory (ART) and Stress Recovery Theory (SRT) (Gillis and Gatersleben, 2015). They found that although there is a good body of literature on the benefits of biophilia, not all aspects that Kellert classified as nature experiences in the building is yet studied enough (Gillis and Gatersleben, 2015). There are reliable sources that admit the role of some attributes of Biophilic design such a natural element; in contrast, there is not enough literature and empirical studies on natural material and processes’ attributes of biophilic design (Gillis and Gatersleben, 2015).

Biophilia design might sound like a luxurious and expensive approach for companies to invest in, but in fact, the corporations can financially benefit from it since it would reduce healthcare costs and increase productivity (Browning et al., 2012). To sum, Biophilia has numerous health benefits including indoor air quality, mitigating stress and increase
satisfaction; thus, considering biophilia aspects is crucial for designing any workplace to provide healthier, more productive working environment (Al Horr et al., 2016).

2.6. The building industry and the issue of stress:

Recently, many built environment associations and building industries pay more attention to public health-related issues and biophilic design (Gillis and Gatersleben, 2015). One of the organizations trying to form the principles of healthy buildings is “The Urban Land Institute’s (ULI),” particularly its “Building Healthy Places Initiative,” which is an international organization. ULI provides a toolkit to enhance health through changes in approaches to buildings and projects. The Toolkit provides 21 evidence-based recommendations that are supported by action-oriented evidence-based and best practice strategies (ULI, n.d.). The ULI Building Healthy Places Initiative employ those toolkits in seven various categories which one of them is offices. These toolkits are classified into three areas; physical activity, food and water and environment (ULI, n.d.). The focuses of ULI is the general well-being that has a wide range and did not address stress an issue of concern, significantly. ULI mostly focused the issue of the stress and the noise (Urban Land Institute et al., 2015).

![Figure 1: The ULI Building Healthy Places Initiative’s recommendations for offices. Each number defines strategies for improvement of health and well-being in offices and not a necessary reduction of stress. (Tinder and Schneidawind, n.d.).](image)

The American Institute of Architects (AIA), is addressing the stress as a health problem more evidently. Since 2013, AIA is started to collaborate with professional continuing education and the Design & Health Research Consortium consisting of 17 universities to expand the body of knowledge of design and health (Tinder and Schneidawind, n.d.). In 2014, AIA’s Design and Health Initiative development of six evidence-based
approaches designers can use to promote health and well-being (“AIA’s design and health initiative - AIA,” n.d.) (Tinder and Schneidawind, n.d.):

1. **Environmental quality:** Preventing, mitigating and reversing chemical and microbial pollutants that harm public health (“AIA’s design and health initiative - AIA,” n.d.).

2. **Natural systems:** Utilizing natural forms, diverse species and existing ecosystems that relieve stress, accelerate recuperation, encourage healthy eating and promote physical and social activity (“AIA’s design and health initiative - AIA,” n.d.).

3. **Physical activity:** Encouraging exercise, recreation, and other daily activities that lower the risk of cardiovascular disease and other health problems (“AIA’s design and health initiative - AIA,” n.d.).

4. **Safety:** Reducing accidental injury and crime to remove impediments to physical activity and alleviate anxiety and stress (“AIA’s design and health initiative - AIA,” n.d.).

5. **Sensory environments:** Diversifying the touch, smell, and acoustics of an environment to promote safety, improve physical, mental and emotional well-being and enhance the quality of life (“AIA’s design and health initiative - AIA,” n.d.).

6. **Social connectedness:** Strengthening personal and professional relationships and encouraging behaviors like civic participation to increase happiness and ensure communities function more effectively (“AIA’s design and health initiative - AIA,” n.d.).

Among those six categories, “safety” and “natural systems” directly address stress as a factor that affects the health being. Alos, “social connectedness” and “sensory environment” are related to the stress. Moreover, AIA provides three strategies based on standards of ‘International WELL Building Institute’ for the workplaces that help clients mitigate stress, increase happiness, and reduce costs; 1-light, 2-acoustics, and 3-temperature (“Start a project,” 2017; Welker, 2016). However, their approach is vague and assume different subjects as one and did not give a clear answer to the mitigation of stress in the built environment.

Internation WELL Building Institute (WELL), also provide seven concepts; 1-water, 2-air, 3-mind, 3-comfort, 4-innovation, 5-nourishment, 6-fitness, and 7-light (“Features | WELL Feature Library,” n.d.). Those seven concepts not only address the design and operations of buildings but also how they impact and influence human behaviors related to health and well-being (“Features | WELL Feature Library,” n.d.).
Another major organization that considers well-being and health as its core disciplines is "World Green Building Council" (GBC). The toolkit is very similar to previous one, but it is more inclined to the practical, sustainable design strategies. The toolkit is Thermal comfort, Lighting, and views of nature, noise, and acoustics, interior layout, Active design and exercise (WGB, 2014a). Recently they have added three more categories to their toolkit for its case studies, “look and feel,” “location and access to amenities” and “employees engagement” (WGB, 2016). There are other entities like Terrapin Bright Green that promotes biophilic design by publishing white papers (Gillis and Gatersleben, 2015).

By studying the literature on intervention, policy strategies in public health and architectural concepts that are provided by architecture and building entities, set of procedures defined such as reducing the noise levels in the workplace, providing to the Social Environment, Access to nature, comfortable temperature, lighting, and setting of the workplace. But it seems their understanding about the relation of stress and design is not complete, and it is not the main concentration of any of those entities now.

3. Discussion:

By reviewing the adverse effects of stress on well-being and health of employees, it seems the first step should be raising awareness and modify the policy of working places and consider mitigation of other demands than physical ones that cause occupational stress. Indeed, the public policy would have a significant effect on reduction of occupational stress in workplaces. The first step would be promoting awareness of the link between stress and health as a valuable goal in workplace wellness (Kivimäki and Kawachi, 2015). Due to the importance of the issue in many countries, preventing extreme occupation stress is becoming a legal obligation (Kivimäki and Kawachi, 2015).

For example; the "European Union Working Time Directive" provides employees with the right to limit their average weekly working time to 48 hours. Also, the European Agency for Safety and Health at Work have launched the healthy workplaces campaign 2014–2015 to promote psychosocial work environment (Kivimäki and Kawachi, 2015). In the international scale, due to the importance of occupation stress, many international organizations such as WHO is targeting occupation stress and provide policies for that. In the United States, there is a regulation that addresses the reduction of stress in the physical environment.; the 1970 Occupational Safety and Health Act (Pub. L. No. 91-596, 84 STAT. 1590, December 29, 1970) mandates the preservation of human resources, which is consistent with considering a range of factors influencing workers’ well-being (Schulte et al., 2015).

According to AIA code of ethics, all architects should consider the well-being of people as their primary responsibility ("AIA Code of Ethics and Professional Conduct - AIA," n.d.). As described, chronic stress has medical, psychological and behavior distress as
an occupational risk factor that makes a significant public health issue, and in reduction occupation stress, architects can play a significant role. On a smaller scale, it is essential that companies employ health, safety, and wellness (HSW) of their employees. Due to this fact, many companies have defined their core values, and these “values serve to define and develop their corporate identity (Zwetsloot et al., 2013).” Thus it is crucial to emphasize the health and reduction of occupational stress in their values. In one of AIA’s white papers, it is stated that nearly three-quarters of U.S. architects claim the health impacts of buildings are influencing their design decisions (Tinder and Schneidawind, n.d.). In addition, there is a high market demand for building owners, and that shape architecture design as well (Tinder and Schneidawind, n.d.).

3.1. The practicality of the Interventions:
As discussed, one of the aspects of public health, as a growing multidisciplinary field, is a built environment, next to other aspects such as social, economic, medical and policymaking. Both public health and built environment are directly dealing with various aspects of community and community-based design. The necessity of studying and improving public health in human’s built environment is now the issue of concerns of architecture, planning and public health profession; thus, there is common ground to start with. The evidence of this growing demand can be traced to professional entities like AIA. AIA started a chapter of public health, and many new interdisciplinary majors are begun to work on that. The same trend can be seen in other built environment and architecture institutes.

Most of the studies, both in public health and architecture, don’t offer sufficient studies focusing on the interactions of occupation stress and design or are look at this issue too general, without focusing on mental health-related design details. Likewise, the policies are now mostly tackling general physical health and safety. The main achievement of this research is providing a set of evidence-based guidelines and patterns that can help the designer and researchers to have comprehensive perspective above the areas that they can intervene in any working places’ built environments.

In this research four broad categories of workplace demands; task demands, role demands, physical demands and interpersonal demands (Quick and Henderson, 2016), that cause distresses are considered as the foundation for categorizing the design strategies. Architects and designers can have positive influence mostly by tackling workers physical demands (needs) and to some extent in workers interpersonal demands (needs).

The author reviews the existing policies, regulation, and guidelines related to occupational risks and health. The Diagram 2. is introduced for further discussion. Also, for each of those categories; the author provides sets of design strategies and toolkits.

The diagram 2. is trying to define the process and relation of distresses and design intervention strategies in the built environment. These two main categories and their
sub-categories are based on human behavioral sciences and biophilia theory and human evolution by considering personal differences.

3.1.1. Areas of intervention in the built environment:

The built environment has different aspects and has different scales. For clarification of this study, three main areas are categorized; Urban, Architecture, and Conjunction areas. Although the meaning of the built environment is broader than urban and architecture definitions (Dannenberg et al., 2011), these two scales are mainly related to office buildings in order to be comprehensive; not only the outdoor environment and the building's indoor but also the transition areas between indoor and outdoor is going to analyze. Many of the following discussions are based on evaluation physiology and biophilia hypothesis.

Another important concept that is associated with occupational stress in any built environment is occupant satisfaction with its many environmental aspects (Alhorr et al., 2015; Annamalai and Kamalanabhan, 2016; Yaacob and Sang Long, 2015). Environmental satisfaction and stress have an adverse collaboration with each other (Tomba Singh, 2014). Another important factor here is having control over one’s environment. There is a direct relationship between having control and recovering from occupational stress (Aronsson, 1989). This effect of control works in both the individual and on the collective level (Aronsson, 1989). Control “meaning that individuals have to determine the influence on outcomes (Aronsson, 1989).” The control here is more subjected to the control on the role and task demands but can extend to physical demands too by focusing more on the predictivity and participation aspect of control.

Diagram 4: The relation between areas of intervention, related to office buildings and human needs
The architecture phase is talking about the interior and building design, the urban one is talking about the location, general situation, and adjacencies and finally, the conjunction area is discussing various options that a building usually connect of the urban context and communicate with it. The strategies in this area would be a synthesis of other strategies that use in two mentioned phases. The conjunction area can be studied in three forms; semi-open, open and enclosed and with three different characteristics; public, semi-private and semi-public.

3.1.1.1. Urban sector:
Many urban studies reported higher rates of “pollution (e.g., air, water), noise pollution (e.g., traffic), specific urban designs (e.g., tall buildings that may be perceived as oppressive), more physical threats (e.g., accidents, violence) (22)”The aim of this article is to examine how increased worker control on the individual as well as on the collective level may be a means to reduce the risk of work environment related stress and diseases. Control is also an important element in socialization processes and in work reform activities directed to a democratization of working life. The concept of control connects a number of research perspectives. It deals with the individual and the collective level, as well as the relationship between them, and it may be a bridge between a social psychological and a psychobiological perspective. In this article, the author considers the control concept primarily from a stress perspective but also examines how production techniques, legislation, and management strategies create the structure of control at work (22) (Gruebner et al., 2017)” in comparison to rural areas (Gruebner et al., 2017). These stressors in the urban areas which have significant effects on the mental health of urban populations (Gruebner et al., 2017). However, even within the urban context, the locations of an office building and its adjacent facilities and amenities play a significant role in the satisfaction of employees and relaxation (Al Horr et al., 2016). Due to the significance of this issue in urban planning, health improvement in urban areas is becoming one of the leading arguments of urban planning approaches, such as Smart Growth and New Urbanism movement (L. Geller, 2003; Sultana and Powell, 2009). Urban intervention for mitigating the adverse effects of stress also associate with the human need to connected to nature and biophilia theory. It seems that the natural urban environments can mitigate levels of stress more than built urban environment (Beil and Hanes, 2013). Dense urban built environment, without green open spaces or even views to natural elements, would hurt mental health of employees. Thus, having more access to natural elements and more greenery in an urban area would lead the employees to have better chance to cope with chronical stress. The urban interventions are not only dealing with the physical and interpersonal demands but are also related to role demands (Quick and Henderson, 2016) of employees. Thus, having easy access to amenities and public infrastructures like childcare, recreational, entertainment spaces and parks would reduce some environmental stressors (Al Horr et al., 2016) and help employees to cope with stress.
better, by using those spaces during breaks (Al Horr et al., 2016) or even before and after of working hours. Also, sprawl an urban structure and absence of public transportation would cause depression, due to the fact people have lower chance to move around and have an active social life (Melis et al., 2015). In the research done on North American workers by Haider, Kerr, and Badmi, shows that frequency of traffic congestion, the satisfaction with, and the duration of, the commute impact stress levels (Haider et al., 2013).

It seems that experiencing the traffic jams more than three times a week would increase the stress level of employees. Also, those who travel a longer distance (longer commute) report a higher level of stress (Haider et al., 2013). Another critical factor that decrees worker’s stress level is satisfaction from their commute (Haider et al., 2013). The vehicle or system of transportation that workers use for transportation would also contribute to stress. Both employees who travel by car or public transportation report some level stress. In some studies like Haider’s team report of similar stress level in both group of employee (Haider et al., 2013). On the other hand, the study that has been done by Gatersleben and Uzzell reports that car users are more stressed than those who depend on the public transportation (Gatersleben and Uzzell, 2007). Also, those

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*Diagram 4: Relationship of office buildings in an urban setting with stress mitigating factors.*
who use a bike or walk to their working places are less stressed in comparison to other (Gatersleben and Uzzell, 2007). Thus, companies that promote walking and biking as transportation system might have less stressed and healthier employees. The substantial role of urban built environment on the mental health of the population is undeniable; however, there are not enough studies between architecture, city planning, epidemiology, geography, neurosciences, and sociology (Gruebner et al., 2017). The urban related interventions have less functionality in our discussion since architects and designers mostly do not deal with this sector directly and it is the issue other professions such as planner and business management. Architects can envolve in this sector if the client asks for their advice for locating their building or setting a master plan of big corporations and offices' complexes.

3.1.1.2. Architecture area:

The central report of this research is the mitigation of stress in architecture scale. The reviewing on the considerable recent literature on stress in different fields resulted in two group of interventions which are the synergy of many stress-related approaches. These two groups are interventions related to the physical demands and interpersonal needs.

Humans are profoundly related to nature and have physical needs that affiliate with it. Access to nature could be passive and active; indoor and outdoor engagement with nature through any or all of human senses (Winterbottom and Wagenfeld, 2015). Many of the strategies that are going to be discussed are based on the evolutionary need to have interaction with nature. Having access to nature can be presented in forms of the interior, exterior landscape and visual in the office buildings. Beside biophilic design strategies, two other physical interventions are going to be discussed; 1- layout and 2- noise level. Noise is a critical physical factor in causing stress (Reinten et al., 2017) and requiring a set of different strategies to prevents.

Another important subcategory of physical intervention is light and its role in well-being and health of people in any building. Other of a group of strategies are about interpersonal human needs. These strategies are trying to address psychological challenges in the workplace that workers deal with it. Human has some similar needs and behaviors, but designers should provide flexible environments that can be meet the needs and preference different individuals.
3.1.1.2.1. Precedent Study:

Two contemporary buildings which WGBC considered them as successful healthy workplaces are going to introduce in this part. The “better places for people,” which is supported by the “Green Building Council” provide some case studies on buildings that
try to improve their wellbeing. They are following the guidelines of “Green Building Council” to evaluate them (WGBC, 2014b);
A—Thermal comfort
B—Lighting and views of nature
C—Noise and acoustics
D—Interior layout
F—Active design and exercise

Toolkit to measure health, wellbeing, and productivity:
- Financial metrics
- Perceptual metrics.
- Physical metrics

**Example: British Land Headquarters**
Location: London, England, Architect: the Commission of British Land
The built environment is the foundation for well-being. From natural light and ventilation to views out and green spaces, the way offices are designed can have a real impact on how we feel. The British Land recent Head Office refurbishment presented an exciting opportunity for them to introduce new features to enhance wellbeing and productivity further (WGBC, 2014a).

Studies show that sensory change can enhance our well-being, making us feel better and become more productive. So, the design team introduced lots of new features to stimulate the senses. They hope that staff and visitors will continue to see new things as the months go by, enjoying their working environment and feeling inspired.

![Figure 2 British Land Headquarters’s interior](image)

**Example 2: Sky’s Believe in Better Building, BSkyB**
Sky’s Believe in Better Building is a four-story commercial office space by Arup Associates; reciprocate of the 2014 Wood in Architecture Award. The office and training facility was designed with the community in mind and the promotion of improved well-being amongst users with flexible office spaces to enhance creativity.

![Image: Interior pictures of B Sky B](image)

**Figure 3: Interior pictures of B Sky B**

3.1.1.2.2. Interventions related to workers physical needs:
This part has five subcategories. Three of those subcategories are related to the biophilia theory and noise, and General Layout group are related to the cognitive and physiological human demands. The same names as Kellert biophilic design strategies are chosen to avoid confusion; 1-direct relation to nature, 2-indirect relation to nature 3-space and place.

3.1.1.2.2.1. Direct relation to nature:

The connection with nature and greenery outside of the building can happen both inside and outside of the building, but employees spend most of their time inside the building(Marcus and Sachs, 2014); thus, indoor natural elements would have tremendous mental health benefits on them.

3.1.1.2.2.2. Indoor greenery:

The employees can connect to indoor nature by viewing nature imagery (still and moving picture); seeing, touching, and smelling indoor vegetation; and hearing nature’s
sounds through an open window or sound recordings, such as birds, water and the like (Marcus and Sachs, 2014). Even a potted plant in an office building is reported as a factor that can affect mood states, stress and well-being of building’s occupants (Dannenberg et al., 2011; Gray and Birrell, 2014; Grinde and Patil, 2009), although some are challenging it by stating the better settlement of the lake of natural context in case of potted plants (Grinde and Patil, 2009). Nevertheless, the outdoor landscapes have a more substantial positive impact on the general well-being of occupants (Grinde and Patil, 2009).

The indoor plants and view to nature in an office can improve the attention capacity and prevent fatigue in work with high attention requirements (Raanaas et al., 2011).

Indoor Landscape Strategies:

1- potted plants in the office.

2- Interior landscape setting.
3- Water in the form of ponds and waterfalls

4- Green walls
The green-wall is now getting common as an interior item in public and commercial building. Green walls have various types such as Freestanding walls, Tray systems, and Panel/modular systems (Editors, 2017). Freestanding walls are like some potted plants on panels, and they are movable and smaller than other systems. Tray system is inserting the separate off-site pre-grown plants on a vertical tray (Editors, 2017). This system has a higher design flexibility since trays can be easily removed and replaced (Editors, 2017). Panel/modular systems are the model that plants are pre-grown into panels that can be used both inside or outside (Editors, 2017).

5- Natural materials

6- Aquarium, fish tanks or fish in water ponds.

7- Pet-friendly environment by considering those who afraid from the pet.
3.1.1.2.2.3. Lightning:

Windows and skylights can make the boundary of a space permeable and extent that space to the outside (Veitch et al., 2013). This association with the psychological concept of prospect and refuge results in a higher level of prospect offer by window and refuge by surrounding walls, space would be more mentally satisfactory (Veitch et al., 2013). Moreover, there is a direct connection between sunlight penetration on job satisfaction (Leather et al., 1998). Light affects people in nonvisual ways and causes medical distresses. Insufficient exposure to daytime sunlight and nocturnal light pollution over time are accompanying to increasing risk of some cancers (Welker, 2016). Therefore it is critical that “workspaces provide regular access to natural light, feature lighting systems that consider circadian rhythms, and reduce sources of glare and visual discomfort (Welker, 2016).”

Also, light has non-visual effects on human body and well-being through the skin (Veitch and Galasiu, 2012). Architects can use light models and other technologies to ensure adequate levels of equivalent melanotic lux at workstations throughout the day, ensuring better rest at night (Welker, 2016).

8- Skylights.

9- Sufficient windows.

Beside providing lights, windows have restorative effects by providing a view to outdoors after stressful experiences (Hartig et al., 1991; Ulrich, 1984; Veitch et al., 2013) by providing a view of outdoors. Each situation requires a specific window.
10-Being close enough (in range of 4.5 meters or 14 feet) to the window.

Also, there is a direct collaboration between worker satisfaction and distance to a window in a private office, which may improve work performance and productivity (Frontczak et al., 2012). However, the designer should be considered thermal and glare problem when the workstation is close to the windows (Aries, 2010).

11-Atriums

12-Building orientation of the sun
13-Daylight imitating artificial light systems

Welker in AIA’s report discusses that “diffuse ambient light or visible daylight may boost moods, while excessive or uneven light may lead to fatigue and visual discomfort (Welker, 2016).” LEDs now offer a real alternative to conventional lighting, with luminaire efficiencies that are now more than traditional technology. This will help to reduce energy consumption for lighting or help to facilitate higher lighting levels but without increasing energy demand (WGBC, 2016). The light color and warmth should also be close to the sunlight and equivalent melanopic lux (Veitch et al., 2013; Welker, 2016) to be considered as biophilic design and therapeutic. In contrast with efficient fluorescent bulbs with a blue light that reported a depressing light, new LEDs mimics the spectrum of natural sunlight and have the higher color rendering and can lower stress and anxiety (Michael Heller, 2016). Those also affect sleep cycle of workers and their general well-being.

3.1.1.2.2.4. Physical connection to nature of building’s outdoor:
As discussed before the human interaction with nature would have a direct relation to relaxation and well being. Also, the open spaces outside of the building provide a context to make employees socialize and have active relaxation and entertainment. Design Strategies:

14-Roof garden.
3.1.1.2.2.5. comfort:

In AIA’s white paper by Welker claimed that “Variables such as humidity, airspeed, metabolic rate, and clothing affect comfort, productivity, and stress levels (Welker, 2016).”

16-thermal comfort
17-natural ventilation
3.1.1.2.3. Indirect relation to nature

It is important the employs can see the nature from their working spaces to accommodate the stress and relax. Velarde and colleagues described the health effects of having a view to the landscape in three stages (Velarde et al., 2007); “short-term recovery from stress or mental fatigue, faster physical recovery from illness and long-term overall improvement on people's health and well-being (Velarde et al., 2007).”

There is not enough research on the values of landscapes settings outdoors and coping with stress, such as natural or urban landscape, to conclude a firm state (Aries, 2010; Veitch et al., 2013). Also, subclassification of urban and natural landscape did a study; however, it seems natural landscape would have better restorative effects (Velarde et al., 2007).

So the windows that only provides daylight are not functioning well in term of reducing occupational stress (Marcus and Sachs, 2014; Welker, 2016). The importance of having a view to the outside might be more related to the perceived openness than to any specific vista (Grinde and Patil, 2009).

Suggested Strategies:

18-Having windows that can provide a view to outside without any visual obstacle for each working stations.

19- Curtain wall with shades for the open offices.
20- Framing the outstanding natural elements in the far such as mountains and forests.

21- In cases with the roof garden make a visual connection.

22- In cases with no view to natural elements or no pleasant view, in the dense urban area; using the flower boxes in front of the building’s windows can help.
23- Using the pictures that represent nature.

24-Having vegetations that have strong aroma inside or outside.

3.1.1.2.3.1. Birds and water sounds

Not every sound in the built environment is unwanted. Sometimes, a background sound would provide can counterpart some of the unwanted noises in the built environment. Moreover, the pleasing natural sounds have to stress restorative effects, according to biophilia theory. Studies show that listening to the bird sound has positive effects on attention restoration and stress recovery (Ratcliffe et al., 2013). Birds can be introduced into the environment, by using interior landscape and atriums as their habitat. Arasbaran cultural center in Tehran, Iran successfully integrate its central interior landscape and atrium with free birds, such as finches, lovebirds, and Budgerigar and provide nest food for them (figure 2). They are free to fly all over public lobbies, auditorium and circulation areas of the building. Ass discussed hostile nature resemblance would have or even adverse effects on stress restoration (Gatersleben and Andrews, 2013), and that is also true about natural sounds. Also, perceptions of restorative value varied among different bird species and related to the symbolic value of them (Ratcliffe et al., 2016).

![Figure 4 Arasbaran Cultural Center’s central atrium which is design for birds habitat. Source: (“Arasbaran Cultural Center,” n.d.)](image.png)

3.1.1.2.4. Space and place:

This part is dealing with the general layout and feel of the spaces. One the evolutionary psychological needs of people for having lower stress is having a low level of refuge and high level of prospects. Also, plans, form, and spaces that represent the nature would have healing outcome based Biophilia theory.
25-Organic plan.

26- Spacious but protected workstations.

27-Diverse and unexpected spaces.

28-Task-based proportional design
The workers who have the tasks that require a higher concentration prefer smaller spaces and those who are dealing with creative and collaborative tasks require larger or open-plan design.
3.1.1.2.4.1. 4.1.1 Noise:

Noise is any unwanted sound that human can hear ("WHO | Chapter 21," n.d.). Adverse effects of noise on human mental health are well studied. Biologically, the heart rate associated with noise. In the research that has been done by Burns et al. (2016), they find that the added noise in the workplace would significantly increase heart rate (Burns et al., 2016). The increase in the heart rate is notable because that is associated with stress hormones in human’s body (Burns et al., 2016). The trace of this effect can be found at all age; for instance, the noise would significantly elevate stress in children (Evans et al., 1998). Most office tasks need a degree of noise control to enable the workers to perform efficiently, and that makes building’s acoustic performance becomes curtail in any office design (Al Horr et al., 2016).

Design Strategies:
29-Acoustic Materials.
30-Using absorptive surfaces can decrease unwanted noise reverberation; like, wall panels and ceiling baffles (Welker, 2016).

31-Acoustic design of the open offices

32-Sound Insolation.
33-Separation of noisy activities in the program.

34-Green boffer zone outside.

35-Providing background sounds

3.1.1.2.4.2. Interventions related to interpersonal needs:

Some of the environmental interventions are about employees’ social interaction and mental health. The most important concepts here are; 1- Flexibility and sense of control, 2- social interaction, 3-active relaxing and 4-personal space and privacy.

3.1.1.2.4.3. Flexibility and sense of control:

Employees have different social determinants, personality, and needs; thus, different strategies should be employed by leaders for stress restoration(Stickler and Scott, 2016). Restricting some people might put them in an uncomfortable situation and stressful situation(Aronsson, 1989). Permitting employees to find their comfort zone would reduce their stress(Welker, 2016).
Flexible office space's approach should consider a variety of “quiet” and “loud” zones in architecture design, to have both speech privacy and vanishing collaboration among workers (Welker, 2016). Another aspect of flexibility is thermal flexibility. The workspace with thermal gradients areas that meet the employee’s different comfort zones can give them this freedom to choose the desirable workstation and improve their satisfaction (Welker, 2016).

36-Control on sound options.
37-Control on daylight option.
38-Controllable temperature option.
39-The flexible choices of workstation and control over the working location.
40-Individually-Controllable Lighting Systems:
Workstation-specific suspended direct-indirect (WSDI-C)s are “luminaires with occupancy sensors, daylight-linked dimming, and individual controls were located centrally in each workstation provided lighting over most of the floor area (Veitch et al., 2010).” Veitch and colleague’s study shows that increasing the environment satisfaction of employees even places with daylight (Veitch et al., 2010).

3.1.1.2.4.4. Social interaction:

The social isolation is a reliable predictor of perceived stress (Ward Thompson et al., 2016). This social interaction would improve the productivity of the institute as well. This interaction can be done among employees and people outside, and local green spaces promote this interaction (Ward Thompson et al., 2016).

41-Gathering spaces inside.
42-Gathering spaces outside.

43-Furniture setting that promotes dialogue.
44-Access to natural possible adjacent green spaces.
3.1.1.2.4.5. **Personal spaces and Privacy**

Although the social interaction is desirable, not all of the time is good. The work setting and interior design can increase the stress level of an employee due to the feeling of losing control of his or her personal space. Many workers report that privacy is an essential satisfaction factor for them. The sense of coherence, a concept developed by Aaron Antonovsky (1987, 1996), is a degree to which people control over their life. How we comprehend, manage, and cope with stress are associated with this sense of control (Winterbottom and Wagenfeld, 2015).

43 - visual privacy of workstations
44 - A personal bubble of the individuals as a design factor (flexible working station). Different people would need particular space between themselves others to feel comfortable. Thus, having flexible workstation can provide the desirable personal space.

3.1.1.2.4.6. **Active relaxing:**

As it is discussed, occupational stress is a significant health issue for employees in office-based professions. One of the interventions to manage stress and recover mental fatigue is a physical activity (Calogiuri et al., 2016). Research done by Calogiuri et al. (2015), shows that, in some indicators of stress, there are more positive effects on stress restoration recorded from those who exercised in the natural space in comparison to that exercise indoor (Calogiuri et al., 2015). This also can be supported by biophilia hypothesis. Thus, having a place for exercise in green space could be one design intervention for stress restoration. Caligiuri’s team called it green-exercise intervention (Calogiuri et al., 2015).

45 - Meditation spaces in a green space.
46 - Entertainment spaces in a green space.
47 - Circulation with green elements.
Another realm of intervention are places of integration of the indoor and outdoor and its effect on well-being and health of employees; thus, designing the adequate semi-public space will be one of the goals of a healthy workplace. To understand the relationship between public and private space, the author did an observation on Chicago’s office buildings and features of their related public spaces.

According to the Kevin Lynch classification of elements of mental mapping of people, we can consider them as “Nods,” which also associate with “Landmarks”(Lynch, 1960). The strategic spots in a city into which an observer can enter, and which are the intensive foci and from which the person is traveling are defined as Nod(Lynch, 1960).

**Group A:**

Some of the semi-public, or office’s plazas, has no definition neither physical nor particular. A vast area, with no border that defines the space cause unpleasant space, cannot play the role of a nod well. Also, the scale of Plaza is not following human scale, and no human interaction traced there.
Figure 7: There are no items in the plaza that people can interact with, enjoy or rest.

**Group B:**
Designers in some of the offices' plazas try to integrate with the public realm, but also create a specific character and physical border to define it as semi-public area. That kind of plazas has more inclination to the public realm than semipublic area.

Figure 8: providing a space for social interaction.
Figure 9: The office’s plaza here is defined with trees, bench and chairs, and tables.

In this example adding an activity that can serve both employees, customers and people can make the plaza to be more live and pleasant. The thing that needs to be improved is the integration of outside and inside of the building.

Figure 10: Defining the space by using multiple items such as trees, urban monument, water, and benches.
Figure 11: the border of this urban node is defined by benches. Those benches, fountain, pond and also the monument in the middle lets the people interact with them.

Group C-
Another group of plazas, the designer defines the space by building or masses. Those have more tendency to the semi-private area. Among those, a group that provides a range of spaces, and enclosures were more successful. Another function of these masses around these semi-public spaces is to break the surrounding building and make more suit to human scale.

Figure 12: The courtyard shape plaza that works well with semi-private space of the office and has a strong sense of place.
Figure 13: The upper level of the courtyard provides spaces for public and work well with the public realm. These two level together provide a large range of the decision.

Figure 14: Same as the previous example the plaza has two distinct levels; one is working more with the public area and another one working with the semi-private area. These spaces show a transforming of space from outdoor to indoor.
According to the literature review and the field study; these design strategies are suggested:

48-Defined public boundaries in the public space.
49-Having vegetation in the public space.
50-Having furniture in the public space.
51-Providing entertainment in the open space.
52-Organic design with diversity.
53-Breaking the vast open area to the smaller area to provide refuge.

4. Conclusion:

As it is discussed, the adverse effect of occupation both on the health of employees and organizations’ productivity. The result of this study is a better understanding of the features of responsible and healthy working places. The outcome of it is set of design strategies that can affect the stress of employee in form of guideline and possible interventions that can help designers to make decisions; in order to, can mitigate the adverse environmental risks are classified. Accordingly, a list of effective interventions for stress mitigations is proposed that can be used in the evidence-based design toolkit of offices and workplaces (Table 2.).

After this systematic review, the author concludes there is a small body of research that directly considers the physical environment as a vector in chronic occupational stress as related agents in the built environment. In Public health literature, most researches are focusing on the diseases caused by stress and medical stressors, and in those cases, they focused on other risk factors such as night shifts and aging. It seems more research is needed to find out how environment causes and heal the occupational stress in working places, within boundaries of public health.

There is a considerable gap in the body of knowledge occupational stress about the design of work setting and another related environmental factor that contribute to that. In the architecture studies, it appears there are not enough first-hand experimental studies in the field of occupational stress. Although their behavioral studies was a hypothetical model for architecture for a long time still the researchers are not focusing on the detailed and specified subjects due to unclear boundaries many human behavioral studies and topics. Mostly they are in the stage to define the general issue with the language of architecture, such as safety, mental health and habitability, and comfort. Also, it an unclearly defined model of study and aims in this realm, undefined critical terms and hypothesis made it hard to gain a clear and reliable practical design tool from them. In addition, there are not enough studies on the weight and value comparison of the five environmental interventions’ categories. Due to the empirical study by Frontczak and colleague, it seems that satisfaction with amount of space, noise level and visual privacy
are three main factors that workers report as satisfactory variables of space (Frontczak et al., 2012). Literature for occupational stress in Management, Businesses, and Psychologies are more reliable and well established. Those researchers provide a model of study and hypothesis they work with and the goals of the research which are mostly improving the productivity and quality of Work life. However, the environmental factors related to occupation is not the main concern or even has other meanings. The positive facts are architecture and public health entities are trying to fill this gap and work closer to improve people Life Quality. To do so, the promotion and education in our case can be one the most significant steps, both in profession and communities. The trace of the shift toward the public health in design professions can be seen in new establishments like the “Design and Health Initiative” (2014) of American Institute of Architecture (AIA) (“AIA’s design and health initiative - AIA,” n.d.). Also, the author suggests that National Council of Architectural Registration Boards (NCARDB) set appropriate regulation to improve the well-being of employees by design. The following table (2) is the principles that Luther concluded from the meta-analysis of more than 100 related sources. Many introduced strategies are synergic understanding of author from the relation occupational stress’s factors and built environment.

### Table 2: The summary of the design strategies that can be used as an evidence-based design toolkit.

<table>
<thead>
<tr>
<th>Categories of sources of stress</th>
<th>Intervention related to the Physical Demands</th>
<th>Design strategies for mitigating the stress</th>
</tr>
</thead>
<tbody>
<tr>
<td>Direct relation to nature</td>
<td></td>
<td>1- Flower boxes and potted plants in the office.</td>
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<td>2- Interior landscape setting.</td>
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<td></td>
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<td>3- Water in the form of ponds and waterfalls.</td>
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<td>4- Green walls</td>
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<td></td>
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<td>5- Skylights.</td>
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<td>6- Sufficient windows.</td>
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<td>7- Being close enough (in range of 4.5 meters or 14 feet) to the window.</td>
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<td>8- Atriums</td>
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<td>9- Building orientation of the sun</td>
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<td></td>
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<td>10-Daylight imitating artificial light systems</td>
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<td>11-Roof garden</td>
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<td>12-Balconies with plants and view to nature or open space.</td>
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<td>13-Thermal comfort.</td>
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<td>14-Natural ventilation</td>
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<td></td>
<td>15-Aquarium, fish tanks or fish in water ponds.</td>
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<tr>
<td>Intervention related to the Physical Demands</td>
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<tr>
<td>Indirect relation to nature</td>
<td>18-Having windows that can provide a view to outside without any visual obstacle for each working station. 19-Curtain wall with shades for the open offices. 20-Framing the outstanding natural elements in the far such as mountains and forests. 21-In cases with the roof garden make a visual connection. 22-In cases with no view to natural elements or no pleasant view, in the dense urban area; using the flower boxes in front of the building’s windows can help. 23-Using the pictures that represent nature. 24-Having vegetations that have strong aroma inside or outside. 25-Birds and water sounds</td>
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<tr>
<td>Space and Place experience</td>
<td>26-Organic plan. 27-Spacious but protected workstations. 28-Diverse and unexpected spaces. 29-Task-based proportional design</td>
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<tr>
<td>Noise</td>
<td>30-Acoustic Materials. 31-Using absorptive surfaces can decrease unwanted noise reverberation; like, wall panels and ceiling baffles. 32-Acoustic design of the open offices 33-Sound Insolation 34-Separation of noisy activities in the program 35-Green boffer zone outside 36-Providing background sounds</td>
<td></td>
</tr>
<tr>
<td>Flexibility and control</td>
<td>37-Control on sound options. 38-Control on daylight option. 39-Controllable temperature option. 40-The flexibility of posture and location.</td>
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<tr>
<td>Intervention related to the interpersonal demands</td>
<td>Social Interaction</td>
<td>Privacy</td>
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<td>45-Access to green spaces</td>
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4.1. Suggestions for future studies:

Author suggests that for future studies, the comprehensive experimental research should be done in the field of occupational stress and its relation to the built environment that considers Architectural, Urban and conjunction area between them. This research should be classified based on tasks and different social determent of the health of employees. It is important that a comparison study between the size of the company and operational stress factors be done in future to provide the basis for related design strategies for mitigating occupational stress.

The social-behavioral and physiological interventions need more research in the workplace, especially in open offices. Privacy and socializing are factors are related to many factors, including culture and it is highly related to the context. Among the list of Physical intervention that the author provided as a guideline, still, there are some topics that there do not contain enough evidence from which to draw a firm conclusion out of them and as such require more studies; these are the topics that author is suggested as for experimental studies in future; 1-color, 2-public spaces and it is restorative features
3- the proportion of space (volume, depth, and height of workplaces) 4- the different effect of landscape setting in different climates. To make it more clear; the questions like; Does an arid landscape setting (xeriscape) have same healing effects as green landscape? What is the definition of nature in this perspective?

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6. References:
Arasbaran Cultural Center [WWW Document], n.d. . Foursquare. URL https://foursquare.com/v/arasbaran-cultural-center--%D9%81%D8%B1%D9%87%D9%86%DA%AF%D8%B3%D8%B1%D8%A7%DB%8C-%D8%A7%D8%B1%D8%B3%D8%A8%D8%A7%D8%B1%D8%A7%D9%86/4df13a5752b100c2d7fc944 (accessed 11.13.17).


Veitch, J., Christoffersen, J., Galasiu, A., 2013. WHAT WE KNOW ABOUT WINDOWS AND WELL-BEING, AND WHAT WE NEED TO KNOW.


Vischer, J., Wifi, M., 2017. The Effect of Workplace Design on Quality of Life at Work. https://doi.org/10.1007/978-3-319-31416-7_21


