Influence of Spatial Layout on Physical Activity and Face-to-Face Interactions in the Work Environment

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ABSTRACT

Lack of enough activity during the day in the workplace has become a serious issue resulting in obesity and health problems. This research explores how interior layout of workspace can affect employees' number of steps and face-to-face- interactions and also investigates whether face-to-face interactions relate to job satisfaction. Twenty one participants were recruited and the data was collected through completing self-report forms to report the number of steps and interactions the participants had daily for ten business days. The data was analyzed using the linear mixed effect models, correlations, ANOVA, and t-tests. The findings support both social ecological model and space syntax theory with positive relationships among distance, depth, the number of steps and interaction, and moderate variables (personal, organizational, and environmental factors). However, there is no significant correlation between interactions and job satisfaction. Since limited studies have been conducted to examine a correlation between movement and interaction in work environments, this research fills the gap of findings from previous literature and makes recommendations for future research.

Keywords: working environments, spatial layout, distance, depth, physical activity, movement, face-to-face interaction, job satisfaction

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CHAPTER 1: INTRODUCTION

Background and Context

An increased risk for various chronic diseases, such as diabetes, obesity, and some types of cancers result from being insufficiently active (Britain, Donaldson, & Britain, 2004; Dishman, Heath, & Lee, 2012). More than one third of adults in the world's industrialized nations are not active enough to receive physical health benefits (U.S. Department of Public Health Service, 1996; World Health Organization, 2011). People can achieve positive effects on health by being moderately-to-vigorously active on a regular basis (Paffenbarger Jr, Hyde, Wing, & Hsieh, 1986; Prodaniuk, Plotnikoff, Spence, & Wilson, 2004). Possible short-term and long-term beneficial health effects, for example, can be weight reduction and lower risk of getting chronic diseases. Paffenbarger Jr et al. (1986) found out two facts by examining 11,000 alumni of Harvard University, after controlling for possible influential factors such as demographics: 1) There is a 20% lower chance to having a stroke or death from all causes for people who climbed 20 floors per week, and 2) People can reduce their weight at least 1.2 pounds per year by climbing stairs for an extra two minutes per day.

However, based on the report of the City of New York (2010), the reality is that the majority of people spend almost 90% of their time working indoors. As their jobs are mostly sedentary (Stokols, Pelletier, & Fielding, 1996), the notable problem is inactivity among workers. From a multidisciplinary perspective, there are some factors to hinder physical activity in working environments, besides spatial layouts. Since office chairs are designed for comfort and ergonomics, fewer movements are made, such as shifting or repositioning oneself while sitting in a chair (Wells, Ashdown, Davies, Cowett, & Yang, 2007). Therefore, employees can be easily observed doing these actions: they send emails instead of visiting a coworker's cubicle and roll across the room to reach something instead of standing up (Wells et al., 2007).

In response to the potential hazard from inactivity and the fact that people spend most of their days in buildings, researchers have started the meaningful impact from sufficient activity, and trying to promote physical activity as much as they can during the day. Undeniably, a well-designed and activity-friendly office layout can provide employees with hidden health benefits, since people's movements are largely affected by the spatial layout. According to Zimring, Joseph, Nicoll, and Tsepas (2005), activity-friendly buildings have visibility, accessibility, pleasant, and supportive features to motivate people to be more active. Hence, countless studies about understanding the behavioral determinants of physical activities in various environments, and the effects of interventions, have been examined (Bauman, Sallis, Dzewaltowski, & Owen, 2002; Dewulf, Neutens, Van Dyck, De Bourdeaudhuij, & Van de Weghe, 2012; Prodaniuk et al., 2004; Sallis, Bauman, & Pratt, 1998; Wells et al., 2007; Zimring et al., 2005). For instance, as the guideline of the City of New York (2010) says, architects and interior designers can encourage forming physical activity, one of habitual behaviors, through a spatial design providing prominent and aesthetically attractive stairs rather than encouraging the use of elevators. Organizing commonly used areas, such as restrooms, cafeterias, copier rooms, mailrooms, and meeting rooms, in pleasant walking distances from individual workstations can also promote walking or travel in office environments (City of New York, 2010).

Being active in working environments can result in environmental benefits as well.

According to the U.S. Department of Health and Human Services (2001), since roughly three to ten percent of a building's energy is typically used for elevators, using stairs rather than elevators can reduce energy consumption, which would eventually lead to reduction of greenhouse gas emissions. Another possible beneficial outcome from increased movement in working environments can be an increased access towards information and ideas (Wineman & Peponis, 2010) due to the higher possibility of communication among colleagues. The longer the distance workers need to make to get to their destination from their workstations, the more opportunities workers have to meet and/or to communicate with other people in the working place.

Research Questions

The following three research questions emerged for this study:

1) Does distance between destinations, which are influenced by spatial layout of the office environment, increase workers' movements?

2) How does workers' movement promote interaction and conversation among coworkers while they move around the office?

3) During communication, do workers feel socially connected with each other? If so, does a socially enhanced feeling affect their job satisfaction?

Definitions of Key Terms

Working environment refers to a spatial area having a functional role for producing any profits as a corporation. As the term has its origin in environmental psychology, any physical spaces designed and used for specific activities can be defined as the concept of workspace, and the places have people's social and professional relationships (Fischer, McCall, & Morch, 1989). The people, who are doing specific activities such as producing profits, are also called as workers.

Layout refers to a part of something that is physically arranged or set up in a particular way. A spatial layout means, especially, the way components in an interior area are arranged.

Distance means an amount of space between two points along a path, and it can be described as long or short. Therefore, in this paper, distance between two or more destinations in working environments means the physical linear length of circulation routes in the space to travel to get from one point to another.

Depth indicates a degree or the number of space people have to pass through from one space to another, and it can be expressed as less or greater.

Physical activity will be described as activity relating to the body movements, which also will be defined as a walking behavior along any possible path, in this paper.

Interaction means having verbal or non-verbal conversation or communication with one or more people. There are two different types of interaction: planned and unplanned interaction. The purpose of planned interactions is usually set up before initiating conversation with others, and planned interactions mostly occur in formally scheduled meeting rooms or individual workstations. Unlike planned interactions, unplanned interactions do not have any initial purpose and can occur anywhere, as an outcome of co-presence or movement in offices (Hillier, 2007; Hillier, Penn, Hanson, Grajewski, & Xu, 1993; Peponis et al., 2007; Peponis & Wineman, 2002).

Job satisfaction refers to an overall emotional fulfillment of employees' expectations or pleasure, and the fulfillment can be oriented from working environments. There are diverse correlated factors with job satisfaction, such as environmental features, physical conditions, or overall environmental satisfaction. It can be usually measured in multidimensional terms.

Purpose and Significance of Research

In this research, the pattern and the hypothetical effects of interactions among coworkers will be discussed as a main result of physical activity. Studies have found that the fundamental impact of physical activity is positive health benefits (Paffenbarger Jr et al., 1986; Prodaniuk et al., 2004; United, 1996; World, 2011), because the action of movement is literally the byproduct of making the body move. In order to have face-to-face conversations, employees need to get up and take a stroll in the office. Even if the purpose of the walk is not to have face-to-face interactions with other people, and employees walk around for diverse reasons depending on their destinations (e.g., restrooms, copier rooms, or kitchen area), the possibility to have unplanned interactions with others can be created. Therefore, employees engage in social interaction with coworkers, and in that process they are able to feel socially enhanced to each other, since even a small talk can bring socially attached feelings. During the conversation, they can also come up with useful information when they are talking about their ongoing projects, and a person who is not related to the project can possibly suggest a third opinion to a certain unsolved problem. Furthermore, the physical activity and communication among colleagues enables workers to become refreshed from their routine work by getting away from their computer. In this study, job satisfaction is able to eventually be an anticipated advantage from these benefits of an increased distance between destinations which can make workers move around more.

Based on the research questions and the significance of this research, Chapter 2 explores a detailed literature review on the findings about spatial layout, movement, interactions, job satisfaction, and habitual behavior. Chapter 2 also provides conceptual framework for this research by reviewing social ecological model and space syntax theory.

CHAPTER 2: REVIEW OF LITERATURE

Overview of Context

This chapter reviews current literature on the relationships between 1) interior layout and people's movement, 2) people's movement and their interactions, and 3) people's interactions and satisfaction. Additionally, this chapter covers literature review on 4) habitual behavior, and 5) social ecological model and space syntax theory which establish the theoretical frameworks for this research. Throughout this chapter, important and related concepts, keywords and variables will be defined and identified as they relate to the study of physical movement and interaction in working environments.

Literature Review

Layout and Movement

Winston Churchill once said, "We shape our buildings and afterwards, our buildings shape us." It is obvious that human beings are affected by environments, such as building design or interior layout, and vice versa. Various studies have been conducted to define the correlation between spatial layout and movement, and they found a positive relationship between the two variables (Penn, Desyllas, & Vaughan, 1999; Rashid, Kampschroer, & Zimring, 2006; Wells et al., 2007; Zimring et al., 2005). Zimring et al. (2005) state that there are three main characteristics of building design that can especially either promote or deter physical activity: "1) the provision and design of activity-programmed spaces, 2) the provision and desirability of activity-inducing spaces and amenities, and 3) the design of the building's circulation system" (p. 190).

In fact, there are some features that hinder physical activity, such as unneeded escalators, overemphasized elevators, and obstacles including grade changes, and nonergonomic design (Leibrock & Harris, 2011). However, activity-inducing spaces, such as cafeterias, mailrooms, or snack bars in offices can give employees opportunities for walking. The building's circulation system, including corridors, elevators, stairs, and lobbies, can motivate workers to engage in physical activity as well (Zimring et al., 2005). Among the building elements, stairs have the highest potential to impact physical activity, since most buildings have them and people can use them easily. Furthermore, based on the benefits of physical activity, the City of New York (2010) made a guideline for both architects and interior designers to consider a way to include stairs in the building layout to promote workers to move more. There has been also an increasing interest in the effects of this kind of intervention for encouraging physical activity in working environments among researchers (Grzywacz & Fuqua, 2000; Prodaniuk et al., 2004; Wells et al., 2007; Zimring et al., 2005).

Notwithstanding the positive effects from physical activity, an individual's intention, among other personal factors which play a moderating role, is the most significant factor in determining one's movements. Zimring et al. (2005) define three different types of activity: 1) recreational physical activity is the byproduct of activity for recreation or pleasure as a purpose such as working out at gyms, 2) instrumental physical activity is routine activity without any pleasure purposes, such as walking to a bus stop, and 3) hybrid physical activity is choosing to be active, even though the choice is not the primary goal, such as walking instead of driving a car. Hybrid physical activity is the most ideal type of activities, but it requires some degree of intention to perform it. Therefore, to encourage hybrid physical activity, designers need to acknowledge the relationship between layout and personal intention. Even though most individuals prefer to follow along a direct and the shortest line, there are always available choices to choose a path, depending on the preference of the individuals.

Environmental factors are critical to the relationship between spatial layout and movement. For example, technology has been developed during the past 100 years to make everyday burdens from in home as well as in the working environment easier (Wells et al., 2007). Bassett, Schneider, and Huntington (2004) explored the relationship between technology and physical activity, and found that the Amish walk roughly 2.5 times more than Americans—on average, Amish men walk 18,425 steps per day, and Amish women walk 14,196 steps per day. Another example is a guideline for the optimal distance between the stove, sink, and refrigerator, which is known as the "Cornell kitchen triangle," or "kitchen work triangle" to minimize the steps for housewives (Child, 1914; Fischer et al., 1989). However, what is paradoxical here is that, even though people want to ease the burden by reducing steps, now this view has been changed by realizing that having more steps can be beneficial in many ways. Undoubtedly, a shorter path is not always the best. For example, the path through a museum can be designed to be long, because people might want to appreciate every masterpiece in that museum. Furthermore, for retail environments, the longer the costumers' path, the more chance they could be exposed to goods, which would lead to higher sales. In short, the notion about and relationship between layout and movement can be changed, depending on the function of the space.

In the study of Penn et al. (1999), the authors delve into the correlation between spatial layout and movements in a working environment by analyzing two different layouts of company X, before and after a renovation. They conducted a post-occupancy evaluation (POE) after eighteen months, including an overall observation and a survey of three staff members from each business. The authors found that the new layout enhanced interaction and communication among business units. The “cold spots”, the space people rarely use or visit, were eradicated because of a compelling effect on the intensity of spatial accessibility of each area (Penn et al., 1999). The pattern of movement was changed as well, such as indicating higher level of movement in the corridors, with highest level on the bridge connecting the atrium to the stairs (Penn et al., 1999). The POE showed an increase in the density of the organization (approximately 28%), and implied that the pattern of movement was greatly affected by the structure of space (Penn et al., 1999).

Axial lines particularly have played a significant role in structuring the patterns of movement, due to the ability of connecting spaces together linearly, representing choices of movement routes. The pattern of movement can be greatly changed by the interior layout with the entrance changing directions, or the degree of depth in the axial map. Interior layout can also impact the tendency, people sit deep area from the entrance, and movement (Penn et al., 1999). To be more specific, higher levels of movement occur in the shallower or more integrated spaces than deeper and segregated spaces, because whether the degree is deep or shallow determines the pattern of movement (Penn et al., 1999).

Over decades, the fact that people frequently choose shorter route has been examined (Hill, 1982; Hoogendoorn & Bovy, 2004; Seneviratne & Morrall, 1985; Weinstein Agrawal, Schlossberg, & Irvin, 2008). After analyzing pedestrians’ habits for choosing routes, Hill (1982) found that people often choose a particular route subconsciously because of directness, including the distance of the route as well as its complexity, as a most common reason. In addition, Weinstein Agrawal et al. (2008) conducted a survey of pedestrians who walked to five rail transit stations to examine route choices. 52% of pedestrians made their route choice because of the shortest or fastest route, and additional 9% of them chose the route due to convenience. The authors also found that almost every pedestrians responded making a route choice of the shortest as either very important or somewhat important (e.g., 82% of responses on very important and 17% of responses on somewhat important). Therefore, the authors concluded that minimizing time and distance is pedestrians' primary consideration in choosing a route (Weinstein Agrawal et al., 2008). As external factors, pleasantness such as visual stimuli and presence of other simulations can play an important role in route choice and preference and walking behavior (Bovy & Stern, 1990; Hoogendoorn & Bovy, 2004; Zimring et al., 2005).

Movement and Interaction

According to Penn et al. (1999), workers need to get up and move through the office to speak to someone or have a face-to-face conversation, and the chance of opportunistic meetings can be increased by moving through the office. Therefore, movement affected by spatial pattern can determine the walking paths to make workers pass coworkers' workstations (Penn et al., 1999). Passing other's workstations by exposes people to ongoing activities, which might be unrelated with one's work or might not need to be shown from one's workstation (Peponis et al., 2007). A positive relationship between the structure of space and the pattern of movement has been shown by many studies (Hillier, 2007; Hillier et al., 1993; Penn et al., 1999; Peponis et al., 2007), however, only limited study has been conducted to examine a correlation between movement and interaction in working environments (Rashid et al., 2006).

The pattern of movement is not the only one affected by the spatial layout in building interiors. Evidence of a positive correlation between spatial pattern and interaction in working organization has been studied through the layout's spatial analysis and the observation data's statistical analysis (Hillier, 2007; Penn et al., 1999; Peponis et al., 2007; Rashid et al., 2006). The main attribute is a direct impact of patterns of space use, depending on spatial layout, on the frequency of contact among workers in working environments (Penn et al., 1999), and the frequency leads to useful interaction between them (Hillier, 2007; Hillier et al., 1993).

Interactions generally take place when at least one person shows his or her availability for conversation when someone is passing by (Penn et al., 1999). People tend to look straight ahead while walking, and to keep their heads down while working, for indicating unavailability and intention not to be disturbed. However, as soon as people turn to look at the common work area or other people, or look up, they can be considered to be available for interaction. Individuals talk to roughly 65% of all other available people, regardless of the distinction of different types of interaction (Peponis et al., 2007). Additionally, interaction can typically be defined as formal planned meeting conversations and informal, unplanned interactions in office organizations (Penn et al., 1999), and the work-related and social interactions are the highest common interaction (Peponis et al., 2007).The fact that over 80% of work-related conversation was observed as unplanned conversation was found by Backhouse and Drew (1992). In terms of the duration of interactions, more than 70% of conversations last less than 30 seconds, and 90%

of conversations last less than two minutes (Penn et al., 1999).

Some research shows that there is a strong preference of having interaction in individual workstation (Hua, Loftness, Kraut, & Powell, 2010; Rashid et al., 2006). After studying ongoing interactions at four different office, the result indicated that the majority of interaction take place in individual workspace (Rashid et al., 2006). Hua et al. (2010) also conducted a field study about 11 different office buildings in eight US cities, including 27 different workplace setting and 308 participants, for two years, and the authors subsequently found a pattern of interaction in working environment. Over 80% participants reported that casual conversation occurs in individual workstations, followed by kitchen or coffee areas of 32% participants' choices (Hua et al., 2010). Moreover, Hua et al. (2010) found workers perceive high support and low distraction from work environments having a longer distance between the workstation and amenities. Ultimately, the study suggests that having a shared service and amenity area in working environment can play a significant role to encourage workers to engage in spontaneous encounters, leading to interactions for socialization, information exchange, and creative development (Hua et al., 2010).

However, there are several other factors determining the pattern of interaction in working environments. Density of occupation and average of spatial integration, which is one of spatial characteristics play an important role in defining levels of interaction (Hillier et al., 1993). Furthermore, the notion that information exchange and communication, which eventually influence job productivity, can be affected by design and layout is supported by a flow model and a serendipitous communication model (Peponis et al., 2007). Based on the serendipitous communication model, people can come out of their workstations due to the purpose of visiting the places serving as informal interaction nodes, such as cafes. Hence, frequent unplanned interaction can make workers' range of communication rather broader (Peponis et al., 2007). Furthermore, visibility, openness, accessibility, and hierarchy can either support or restrict chance encounters that make meaningful interactions (Rashid et al., 2006). For example, people who are in the more accessible spaces in the building, are greatly visible and reachable, because a person's location can determine the possibility of interaction with others (Penn et al., 1999).

According to the results of the study conducted by Rashid et al. (2006), based on the analysis of four different large offices' spatial layouts and behavior patterns, even though the offices offer collaborative workspace to encourage interaction outside the individual's workspace, most interactions occur in the workstation. However, there is a considerable difference about other locations supporting interactions, such as the corridors or a common area, depending on the different spatial cultures of interaction in the office organization (Rashid et al., 2006). The spatial culture of interaction is a crucial factor, since the other locations for interaction are largely affected by the spatial culture of interaction. Those factors can drive workers to prefer having face-to-face interaction in individual workstations as well. The authors emphasize that organizational function and culture are substantial factors to determine the pattern and the goal of interaction, by providing plentiful evidence in terms of accessibility, visibility, and organizational hierarchy through a space syntax analysis (Rashid et al., 2006).

In addition, Rashid et al. (2006) found a strong and positive correlation among co-presence and interaction, and a weak positive correlation among movement and interaction. That means, disregarding movement in these office layouts, researchers can predict co-presence's effects on interaction (Rashid et al., 2006). However, in that study, the authors observed and analyzed overall impact of movement on interaction in working environments. Unlike the previous study, in this paper, the distance of each individual's travel from his/her workstation to another's workstation or common area will be measured; therefore, the impact of an individual's travel distance on degree of interaction will be examined.

Interaction and Satisfaction

The impacts of physical characteristics of working environments, such as the density of the office or the height of partitions on employees' behavior and attitude has been continuously getting researchers' attention for many years (Oldham & Fried, 1987; Rashid & Zimring, 2008). This notion is supported by the fact that individuals have a tendency to communicate and interact with others when physical settings of buildings promote them to do so. From an occupational psychological perspective, several theories have explained that job satisfaction can be directly and/or indirectly affected by diverse factors, and job satisfaction and job performance are closely related to each other. The person-environment (P-E) theory, which is widely applied to organizational psychology, especially, explains the behavioral outcomes as the interaction/fit between a variety of P and E variables. Based on Parson's (1909) P-E fit theory, the Theory of Work Adjustment (TWA) was introduced (Dawis, 2005; Rounds, Dawis, & Lofquist, 1987). According to the TWA, working environments (e.g., atmosphere, interactions and social support among workers) can play a key role in convincing employees stay longer (tenure) (Rounds et al., 1987). Emotional depletion and exhaustion will finally result in job burnout, affected by both job satisfaction and job performance (Maslach, Schaufeli, & Leiter, 2001).

From the perspective that physical layout considerably affects patterns of communication and social interaction, the concept of the open-plan office was introduced in the United States in the 1960s to spur efficient communications among workers (Sundstrom, Herbert, & Brown, 1982). In general, open-plan office refers to a place that features the absence of interior walls, partitions, or rooms (Oldham & Brass, 1979). Even though the main purpose of the open-plan office is greater accessibility to make communication easier, the openness of the space is likely to make satisfaction with privacy and acoustics lower at the same time. These benefits and disadvantages of open-plan offices have remained an unsolved dilemma among practitioners for decades and are still being debated (Oldham & Brass, 1979; Oldham & Fried, 1987; Peponis et al., 2007; Rashid & Zimring, 2008; Sundstrom et al., 1982; Zimring et al., 2005). To be specific, one of the primary aspects that make people feel dissatisfaction from their open working environments can be overstimulation, i.e., too many people, too many interactions, or too close proximity to others (Oldham & Fried, 1987). However, in this research, interactions occurring exclusively during the work hours will be the focus, regardless of the degree of the office's openness. This paper will further explore the potentially increased job satisfaction of workers through the interactions in several ways, such as interpersonal familiarity, frequency of interactions, and usefulness of the information exchanged.

The close relationship between familiarity with others and interaction, which would enhance attraction in turn, was established a few decades ago (Oldham & Brass, 1979). It has been also discovered that habituations of interaction pattern and rigidity are able to be formulated by familiarity among teams and groups (Gorman, Cooke, Amazeen,

& Fouse, 2012). Gullahorn (1952) conducted a study to scrutinize frequency of interpersonal contact, which refers to friendship opportunities among coworkers, by examining 37 employees for two and a half months. According to the article, to form friendships among coworkers, which can fulfill employees' social and emotional connectivity with others, interacting with coworkers more frequently is one of the critical factors. In particular, frequency of interaction plays a more significant role for the younger groups to develop employees' job satisfaction through friendship, while proximity is a more significant factor for the older groups (Gullahorn, 1952).

In terms of frequency of contact and familiarity among workers, as described in the previous section on layout and movement, Penn et al. (1999) launched a survey of three staff members from each business. The authors found that the mean frequency of both interaction and encounter with others is affected by spatial accessibility (e.g., the spatial isolation), and that the frequency can determine usefulness of interaction (Penn et al., 1999). The more frequently the worker interacts and has contact with others, the more that worker might feel and assume that the others are useful people and that the conversations produce useful information for his or her work.

In addition, based on the fact that any increase in interaction affects organizational outcomes by any increase in interaction, informal communication can be seen as a suitable way to spread ideas (Rashid et al., 2006). A spread of information, improved coordination, reduced process redundancy, and greater organizational efficiency are the examples of benefits coming from any increased interactions. Moreover, both performance and satisfaction with work can be enhanced by appropriate and accurate exchange of information through the interactions. In short, Pettit, Goris, and Vaught

(1997) said: “Individuals receiving proper, correct, and clear information may perform adequately, which in turn may give rise to positive feelings about their jobs, or vice versa” (p. 93).

Furthermore, to an individual’s health and well-being, the degree to which an individual is interconnected and embedded in a certain community is crucial, since social support and social networks are both indispensable prospects for understanding interpersonal relationships (Berkman, Glass, Brissette, & Seeman, 2000; McNeill, Kreuter, & Subramanian, 2006). In general, social supports are referred to as resources supported by other people (Cohen & Syme, 1985). On the other hand; social networks can be defined as structures representing social relationships to surround individuals and grant them with information on how much an individual is interconnected with others (Institute of Medicine, 2001). As a vital “buffer” in terms of an employee’s stress level at work, low social support or isolation can bring negative job outcomes, whereas high support can give workers relief from the negative effects of high-strain jobs (McNeill et al., 2006). A social network also enables people to feel attachment and connectedness to others (McNeill et al., 2006), which would affect the worker’s job satisfaction emotionally.

However, it is undeniable that job satisfaction and job performance are closely correlated with each other. Therefore, researchers have tried to formulate the exact relationship between the two elements. Judge, Thoresen, Bono, and Patton (2001) developed seven different job related relationships between the two variables by reviewing over 300 articles in both a quantitative and a qualitative way. The authors found that the strongest relationship between job satisfaction and performance, and also found other possible variables to influence the relationship. Considering the importance of communication in organizational functioning, the degree of communication in working environments as a moderator in the job satisfaction-performance relationship has been investigated (Pettit et al., 1997). Accuracy of information delivered through communication among workers is one of the greatest moderators in the relationship, besides desire for interaction, trust in and influence of superiors, and satisfaction with communication (Pettit et al., 1997). In short, exposure to appropriate communication such as having trust, accuracy, and credibility, improves job performance bringing increased job satisfaction. However, this research seeks to add to the knowledge base surrounding the above discussion by bringing additional evidence that sheds new light solely on how interactions in working environments have differential effects on job satisfaction.

Habitual Behaviors

The terminology of habits has been generally agreed among many researchers for many years; habits are repeated actions performed frequently and operated without a large amount of cognition, which can be interpreted as actions activated automatically as well (Jager, 2003; Neal, Wood, & Quinn, 2006; Wood, Tam, & Witt, 2005). According to an investigation conducted by Quinn and Wood (2005), approximately 47% of daily behaviors were performed repeatedly in the same location and almost every day. Because of the automaticity of habitual behaviors, people can minimize their cognitive efforts; however, their habits are less prone to be changed than reasoned or planned behaviors at the same time (Jager, 2003). Notwithstanding the unlikely changeable aspect, there are several reasons one may need to change certain habitual behaviors. For example, Neal et al. (2006) especially mention that “five of the leading health risks in the U.S. emerge from everyday repetition of action—substance abuse, obesity, tobacco use, risky sexual behavior, and inadequate exercise” (p.200).

To understand the process of changing habitual behaviors, four types of causal variables are introduced by Stern (2000). The first factor is *attitudinal factors* including individual’s norms, beliefs and values. *Contextual forces* are the second main type and include interpersonal influences (e.g., persuasion); government regulations; capabilities and constraints generated by technology and the building environment (e.g., building design), which will be focused on in this paper; and so on. As a third type of causal variable, *personal capabilities* include the knowledge and skills for the actions, and the availability of time to act. The last type of causal variable is *new habit* (Stern, 2000). Moreover, in order to support changes of habitual behaviors, Werner, Cook, Colby, and Lim (2012) adapted the behavior change model to explain four different supporting levels: individual level, supportive social milieu, physical environment support, and economic and policy support.

In order to motivate people to choose to perform recreational, instrumental or hybrid physical activity over just sitting at their chair or rolling chairs across the office, there are several potential suggestions. Removing cues to performance and/or creating new circumstances might lead to habitual behaviors changing by eliminating cues for automaticity and/or setting a new intention and goal (Wood et al., 2005). Persuasive messages from campaigns and other interventions can be another solution to change people’s sedentary behavior; however, it has had limited effect on changing behaviors (Neal et al., 2006). The possible reason is due to the fact that habits do generally take limited or none of new information into consideration and that people might not perceive the new information (Jager, 2003). In other words, minimizing the environmental factors automatically affecting habit performance, time, and repetition will work to break current sedentary habits and to create new active habits (Kremers & Brug, 2008).

For example, van Nieuw-Amerongen, Kremers, De Vries, and Kok (2011) conducted research to examine whether stair use among students and employees of a university in the Netherlands would be influenced by increasing the attractiveness and accessibility of stairs. The study used multi-directional environmental interventions, such as prompts and enhanced aesthetics, visibility and accessibility. The authors observed users (both students and employees) by using video cameras. Data were constantly collected 1 week prior to and 4 weeks after implementing the intervention. 21,798 cases were observed, and the results show there was an 8.2% increased use of stairs and remained quite stable over the 4 weeks. Even though this study contains few limitations since it does not consider collecting data during the intervention period and the density of elevator use, the result indicates intervention may impact people's habitual behavior. In another study, the potential effects of implementing interventions were investigated regarding college students' habits of leaving the classroom without turning off the lights (Werner et al., 2012). There were two different types of interventions (e.g., presentation and reminder sign), and 2x2 factorial design was utilized over three periods (e.g., baseline, intervention, and follow-up). The result shows that a presentation would be more affective intervention than a sign, and that there was little or no impact on changing habits of turning off lights when a sign was posted without connecting it to a presentation.

Ideally, a habit is susceptible to be changed more if the following situations would be provided: (1) the limiting the existing habits and situations, (2) the availability of clear information on the long-term negative outcomes of existing behaviors and positive outcomes of alternative habits, and (3) the providing information on the short-term positive outcomes of alternative behaviors (Jager, 2003). In summary, if people have positive attitude toward physical activity, feel social pressure to do so (subjective norm), and think they can do successfully (perceived behavioral control), they are more likely to engage in physical activity (Armitage, 2005).

Theoretical Framework

Social Ecological Model

A social ecological model was originally developed from the ecological perspective; significant progress in mostly health-related practices has been made due to this perspective (Green & Kreuter, 2005). According to the social ecological model, physical and social environments characterize the ecological view interdependently (Stokols, 1996) with multidimensional and multilevel standpoints, which are personal, organizational, and environmental factors (Green & Kreuter, 2005; Grzywacz & Fuqua, 2000). The social ecological model has been adopted to explain the multiple relationships of physical activity with those multidimensional factors (Grzywacz & Fuqua, 2000; Prodaniuk et al., 2004; Sallis et al., 1998; Zimring et al., 2005). Based on the article of Zimring et al. (2005), environmental factors, such as urban design, site design, and building spatial design, have a direct relationship with physical activity. However, both personal factors (e.g., demographics, health variables, and attitudes) and organizational factors which might support or impede physical activity (e.g., social structures, organizational supports, and philosophies) can moderate the environmental factors' roles

(Zimring et al., 2005).

Social ecological models demonstrate complex and associative correlations among individuals and environments as rather more comprehensive understandings, and highlight the importance of behavioral influences from the three multiple levels (Grzywacz & Fuqua, 2000; McNeill et al., 2006; Sorensen et al., 2003; Zimring et al., 2005). The most important point of the social ecological model is the fact that behavior is affected by environmental factors and individual factors at the same time (McNeill et al., 2006). Therefore, a social ecological perspective suggests an interaction that is individual as well as social within a physical environment, and states the need to increase the concept of a “person-environment fit” (Stokols, 1996).

Utilizing the viewpoint of Sallis, Owen, and Fisher (2008), who define environment as beyond a human’s area, Wells et al. (2007) examined the diverse potential influences of environments (e.g., clothing, food environment, technology, building design, urban design, and natural environment) on physical health. The author further explored that these environmental factors might either support or hinder physical activity. Consequently, researchers can stretch to consider a broad scope of achievable application and collaborations to make positive contributions on this multidisciplinary field because of this extended conceptualization of environments (Wells et al., 2007).

However, personal, organizational, and environmental factors can be too broad and ambiguous to conduct research, especially when they are considered together. Indeed, Sallis, Johnson, Calfas, Caparosa, and Nichols (1997) declare that such a broad range of factors, like biological factors having effects on physical activity might lead to insignificant correlations between physical activity and the environment. Hence, Grzywacz and Fuqua (2000) argue that before conducting research, there is a need to define personal, organizational, and environmental factors specifically, and to acknowledge the fact that possible contributors such as various individual characteristics, can produce different results on physical activity. Researchers can obtain the benefits of a social ecological perspective by narrowing and defining these three factors. In this way, more unequivocal implications about the relationships among variables can be created and these specific implications can help researchers to apply the findings further (Grzywacz & Fuqua, 2000). Additionally, by paralleling the findings at multiple levels, researchers dodge possible obstacles for proper application another advantage of the social ecological perspective, (Grzywacz & Fuqua, 2000).

Owing to these advantages of social ecological perspectives, there has been a tendency to conduct studies to find out the potential working environmental factors to encourage employees' physical activity, based on an ecological approach (Stokols et al., 1996; Wanzel, 1994). Due to the fact that the environments where people interact are the key interest of ecological model, to scrutinize wider spectrum of a person's life surroundings having an intervention, the ecological approach has been utilized (Gauvin, Levesque, & Richard, 2001). To summarize, when researchers examine the environmental influence on physical activity the environmental factors should be included (Prodaniuk et al., 2004).

Space Syntax Theory

In general, space syntax means both the theory and techniques for analysis of a spatial system. Space syntax theory and techniques, used for analysis of accessibility and visibility, were originally developed for street and neighborhood design (Hua et al., 2010).

In this research, the possible relationships among variables will be examined through space syntax theory. For analysis of interior layouts, researchers can examine the way face-to-face interaction is affected by a spatial system by looking into movement's lines and visible co-presence (Peponis & Wineman, 2002). Therefore, a two-dimensional building plan can be measured quantitatively, by showing patterns of potential movement and relationships of spatial lines or units, analyzed through a space syntax analysis method (Peponis & Wineman, 2002). Thereby, the overall layout of the building can be examined (Hua et al., 2010).

Six constructs in space syntax theories are openness, depth, connectivity, accessibility, the degree of control, and visibility (see Table1) (Hillier et al., 1993; Zeisel, 2006).

Table 1

Six Constructs of Space Syntax Theory

Constructs	Description
Openness	The degree of spatial enclosure in a setting
Depth	The number of spaces a person would have to pass through going from one space to another
Connectivity	For a single space, the number of other spaces directly connected to it. For a convex graph, represents the number of other spaces directly accessible from it For an axial graph, the number of axial lines that cross another axial line
Accessibility	Representations of spatial configurations in which a person passing through a series of spaces would end up back at the original space
Degree of Control	Calculated characteristic implies a social or behavioral correlate to the physical relationships of spaces in plan (i.e. degree of control a person feels over social interactions)
Visibility	Represents the opportunity of people moving through a sequence of spaces to see into other adjacent spaces

Adopted from *Inquiry by design: Environment/behavior/neuroscience in architecture, interiors, landscape, and planning*, by J. Zeisel, 2006, p. 344-345. Copyright 2006 by W.W. Norton & Company.

In addition to the six constructs, *configuration*, which is creating a discrete individual unit converted from the constant space, allows the assigning of different labels to the unit (Bafna, 2003). By examining the configuration, researchers are able to develop either a convex map or an axial map (see *Figure 1*), depending on what aspect of the building they want to analyze (Bafna, 2003). A convex map is better for understanding the organization of the spatial system and the general type of buildings, on the other hand, an axial map is more useful in finding out behavior patterns within the spatial layout (Bafna, 2003). There is also a need to know two key terms, *connectivity* and *integration,* to understand space syntax theory. Connectivity, which is the local property, describes the number of axial lines directly connected to spatial units; it also means the degree of choices for the line.

Figure 1. An example of how to use axial lines by using space syntax theory. Adopted from "Space Layout and Face-to-face Interaction in Offices—A Study of the Mechanisms of Spatial Effects on Face-to-face Interaction", by M. Rashid, K. Kampschoer, J. Wineman, and C. Zimring, 2006, *Environment and Planning B: Planning and Design, 3*3, p 828

On the other hand, integration, which is the global property, represents the average degree of how much an axial line connects to all other axial lines in an axial map, so the whole spatial configuration is able to affect integration (Bafna, 2003; Hillier et al., 1993; Rashid et al., 2006; Wineman & Peponis, 2010). In other words, Rashid et al. (2006) define connectivity and integration by stating that "the higher the connectivity of an axial line, the greater is the number of choices of movement from the line, and the higher the integration value of an axial line, the easier it is to get to the line from all other lines" (p. 828). Therefore, *intelligibility*, one of the key terms in space syntax theory is generated based on the predictable correlational effect between connectivity and integration (Wineman & Peponis, 2010). To be specific, intelligibility enables researchers to measure the predictability of global property and local property (Bafna, 2003; Hillier, 2007; Hillier et al., 1993).

Because of these characteristics being able to objectively measuring spatial configuration with multiple constructs, rather than simply measuring space through traditional metric distance, space syntax allows researchers to examine the relationship between space and society (Bafna, 2003; Wineman & Peponis, 2010). In other words, the more integrated the spatial system, the easier people can travel from one space to another, and conversely, the more segregated it is, the longer the path (Wineman & Peponis, 2010). However, there is a difference between intelligibility and accessibility. Whereas accessibility is about function in having face-to-face interaction or getting information, intelligibility can show overall patterns among individual configurations, containing an organization's spatial culture (Peponis et al., 2007).

Even though previous literature reviews have discussed the significant effects of spatial layout on movement and face-to-face interaction in an office environment, there are limited studies that investigated the relationship of movement and interaction through different spatial layouts (Rashid et al., 2006). The study by Rashid et al. (2006) explores the valuable relationship among movement, visible co-presence, and face-to-face interactions through analyzing four different offices based on a space syntax method. The study 's analysis of four offices was conducted by using computer software to create an axial map, after measuring the values of connectivity, integration, and depth (Rashid et al., 2006). Similarly, Peponis et al. (2007) discusses the impact of spatial layout on patterns of interaction and information's flow by analyzing an office's old and new layout, from a space syntax theoretical view. Additionally, by examining two different office layouts, before and after renovation of the spaces, Penn et al. (1999) found that the pattern of movement based on spatial layout as well as its direct impact on the frequency of communication between workers. Space syntax is preferred among researchers because it has several advantages; the ability to rigorously describe the spatial layouts' genetic properties, and to minimize the possible errors of defining variables by using an axial map without ambiguity (Rashid et al., 2006). Therefore, depth, one of the six constructs, will be further examined in this research, since it is closely related with distance. The two concepts, distance and depth are able to show a spatial layout's characteristics.

Conceptual framework and Variables

Based on space syntax theory and the social ecological model, a conceptual framework for this research was developed (see *Figure 2*). The independent variables are the distance and depth between destinations, some of the environmental factors, influenced by the spatial layout of the office environment. Depth is the only construct explored from space syntax theory for this research. The office layout determines the employees' path, or that need to move from point A to point B; movement from one workstation to another person's workstation or common area (e.g., kitchen, restroom, or copier room) is determined, dependent on the office layout. As a mediate variable, the pattern of movement could have a longer path or a shorter path. Herein, movement can be defined as any activity of walking along the path by showing the number of steps people walk during the work hours. Depending on the distance, depth and the number of steps, the number of interactions with others can be varied.

For example, if someone’s workstation is located far away from the restroom, say about 50 steps, this person needs to walk 50 steps to get to that person’s destination, the restroom. While he or she is walking to the restroom, the person might have more opportunities to meet someone and have a personal conversation in the corridor or restroom than someone who has his/her workstation closer to the restroom, say 10 steps away. On account of this assumption, an increased opportunity to communicate (the number of face-to-face interactions) while the workers are moving around the office is a dependent variable, and the opportunities would eventually influence job satisfaction.

Finally, there are three different moderate variables, which make the relationship between the distance and the pattern of movement stronger, by supporting both variables. To explain the role of moderate variables with more specific definitions, Wells et al. (2007) define moderate variables as that: “moderators address “it depends” types of relations; the effect of A on B depends on the level or category of a third variable, the moderator” (p. 25). Under personal factor, there are gender, age, and number of years a subject has been working at the corporation. In addition, whether the office has open-plan or private office and/or the height of partitions are the examples of environmental factors; moreover, whether the office has flat or hierarchical work environments, retention of employees, and/or flexible or rigid work schedule can be organizational factors. For example, nowadays, with the development of technology, younger generations prefer to communicate with others via online chatting, SNS (Social Network Service), or their smart-phone. Therefore, since all three moderate variables might influence the pattern of movement, defining the possible relationship among movement, personal factors, and environmental factors make more sense to build up a vigorous relationship.

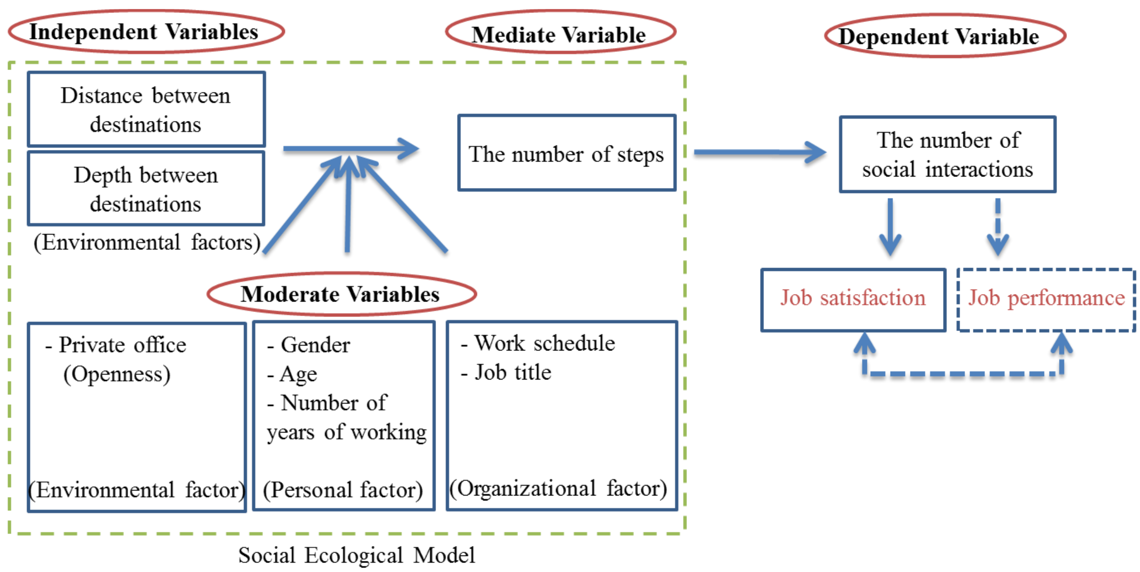


Figure 2. A conceptual model for this study

Hypotheses

Four hypotheses were developed for this research, based on the conceptual framework to examine the relationships among distance, depth, the number of steps, and the number of face-to-face interactions, potentially leading to job satisfaction. The hypotheses follow:

Hypothesis 1: Increased distance and depth between an employee's workstation and other destinations will increase the number of steps they walk.

Hypothesis 2: The greater number of steps will correlate to the number of face-to-face social interactions with others and play a mediating role.

Hypothesis 3: The greater number of interactions will correlate to higher job satisfaction.

Hypothesis 4: Personal, organizational, and environmental factors will play a moderating role between distance and the number of steps.

For testing these hypothese, Chapter 3 present how the methodology were used and data were analyzed for this research.

CHAPTER 3: METHODOLOGY

Overview of Methodology

This chapter describes a quantitative design developed to gain a better understanding of how interior layout in work environments, employees' physical movement, and their social interaction among coworkers correlate, and how job satisfaction is be affected by the interaction. Additionally, this quantitative research examined how personal, organizational, and environmental factors support or hinder the relationship among those variables.

Data Collection

Participants and Procedures

For this quantitative study, data were collected from Office A, a local architecture studio. From Office A, 21 voluntary participants were recruited, however, two people dropped out at the beginning of the data collection. Further, a data set from one participant was excluded from this research because of unqualified data. Therefore, the total participants for this study were 18. There were 6 males and 12 females. Participant ages ranged between 18 and 45 year-old. For this research, there were no specifically established criteria for participation.

The study was conducted in early February, 2015 upon receiving approval from University of Minnesota IRB. The study was supposed to collect data during 10 working days. Since every participant had different schedules such as working out of office, attending off-site meeting, or field trips, the starting and finishing date for the data collection of each participant varied. Overall, the data were collected from Feb 9th to Mar 3rd, 2015.

Once every employee participating in this research submitted a consent form with their signature, they received a research package containing a self-report form with instructions (see Appendix C), a device to count his or her steps, and one questionnaire. Participants were trained to fill out self-report forms by the principal investigator. The questionnaire (see Appendix A) was provided at the beginning of the data collection, and the participants were asked to submit it with their initial self-report form within a sealed envelope due to confidentiality. Because the data needed to be tracked for data analysis such as correlation among their movement and/or interaction and demographic information and/or job satisfaction, participants submitted their first self-reports form with the questionnaire in a sealed envelope.

Self-report Form

The majority of the data were collected daily through self-reports by participants. A floor plan printed on 11x17 paper was provided every day (see Appendix B). When a participant came to the office, he/she needed to put on a pedometer for the entire work hours. However, if a participant was out of office for off-site meeting, lunch, or working out, he/she was required to take off his/her pedometer and when he/she came back to the office, the participant was asked to put the pedometer back on. A participant was required to report the time when he/she came to the office and left the office and the time when he/she left the office for an off-site meeting and came back to the office. He/she should also report the number of steps on a pedometer when he/she left the office. A participant was asked to report every single trip whenever he/she made some physical movements (e.g., leaving his/her own workstation and coming back). A participant was also asked to draw their path on the floor plan. The destination should be represented with a dot. If a participant traveled along the same path more than one time, he/she needed to put slash(s) (e.g., /, //, ///, etc., based on the number of trips) on the path. If a trip has multiple destinations, a dot at each destination should contain the number of the destination's order (e.g., first destination would be represented as 1, second destination as 2, etc.).

In addition, for an interaction, a participant needed to draw a star beside a destination (represented as a dot), whenever he/she had a face-to-face interaction while walking through the path. The number of stars at each destination means how many face-to-face interactions a participant had along the path to each destination. The location where the interaction occurred did not need to be exact, since the study focused on the number of the social interactions the participant has while traveling. Moreover, as this study measures the social interaction as a face-to-face interaction, all the interactions reported should be face-to-face interactions. In other words, if participants had a conversation over the partition without seeing each other (e.g., sending email, talking over the phone or a partition), that conversation should not be counted as an interaction for this study.

Questionnaire

Subjects also were asked to complete a questionnaire (see Appendix A). The questionnaire consisted of three parts; 1) job satisfaction, 2) habitual behavior, and 3) demographic information. A questionnaire asked the subject's demographics, such as gender, age, number of years he or she has worked in the corporation, and whether or not a participant has difficulty in walking. The instrument for measuring habitual behavior was developed based on the Self-Report Habit Index (SRHI). SRHI has shown high internal reliability, convergent validity, and construct validity towards physical activity, and it has a format of a self-report instrument that measures habits with twelve different items (Kremers & Brug, 2008). For this research, only six questions from SRHI were used.

Work Design Questionnaire (WDQ) was utilized as a comprehensive measurement for job satisfaction. The WDQ has three main characteristics; the motivational, the social, and the contextual characteristics, and under three characteristic categories, 76 questions were developed (Morgeson & Humphrey, 2006). To be specific, the motivational characteristics cover ten different concepts (autonomy, information processing, problem solving, skill variety, task variety, specialization, significance, task identity, feedback from job, and task simplicity); the social characteristics cover four concepts (interdependence, interaction outside organization, feedback from others, and social support); contextual characteristics cover four features (ergonomics, physical demands, work conditions, and equipment use) (Morgeson & Humphrey, 2006). Eight motivational characteristic questions, nine social characteristic questions, and five contextual characteristic questions were included in the questionnaire to figure out the participants' overall job satisfaction.

The majority of questions for this questionnaire used a five point Likert-type scale to record the participants' responses, using a scale of "1" as *strongly disagree* to "5" as *strongly agree* with "3" as *neither agree nor disagree*. To find out what the participants thought of their job satisfaction and habitual behavior of physical movement, they were asked to show their opinion on each statement by choosing from "1" to "5". Furthermore, the participants needed to show their opinions on the question "*I have no difficulty in walking*" with a five point Likert scale between *strongly disagree* and *strongly agree*. At the end of the questionnaire, there were three demographic questions: their gender, age, and the number of years in the workplace. Additionally, the information about the participants' names and job titles was given to the principal investigator when recruiting participants for this research; therefore, the principal investigator was able to track all their information throughout the research.

Instrument

A pedometer was used for this research to count a participant's daily steps. The 26 pedometers, which were initially prepared, distributed, and used, were *Step-Counter Pedometers* made by AdVantage Industries. However, they are very low end technology and quality even though they claimed +/- 10% accuracy. Because of having many issues (e.g., automatically reset several times, broken waist/belt clip) on the first day of the data collection, two different kinds of pedometers were used from day 2, both made by Sportline. Ten of *2-Function Step and Distance Pedometer* (Model #SB1061BK) and two of *Triple Function Calorie Counting Pedometer* (Model #SB1062BK) replaced the initial pedometers and were used for the rest of the data collection.

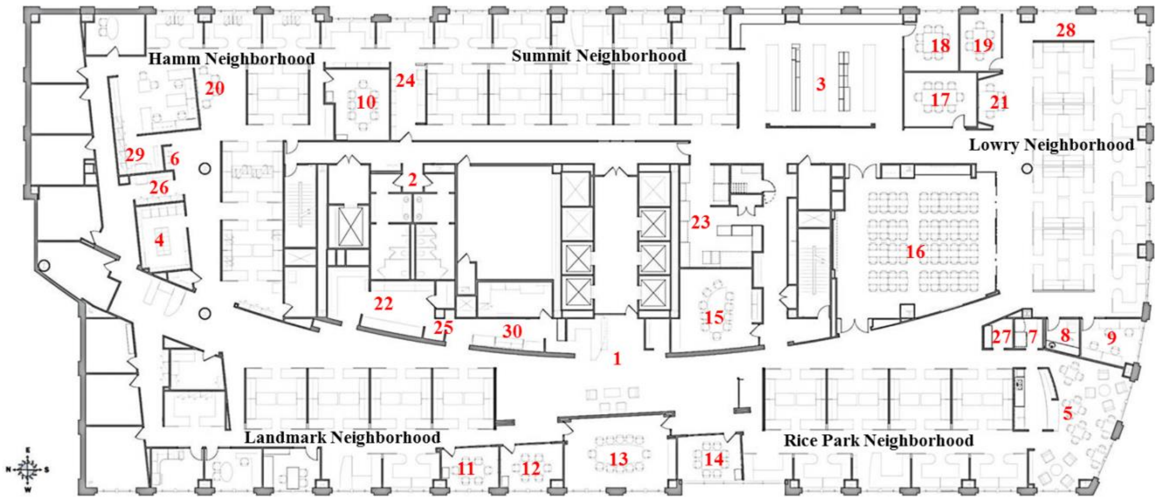
The Workplace

Office A, a local architecture company, which was recruited for this research is located in the downtown area in St. Paul, Minnesota and was established in 1992. Office A has 28,007 ft^2, which excludes some common areas within the building such as elevator, lobby, restrooms, etc. The total employees at the office are 138; there are 129 in St. Paul, 7 in Madison, Wisconsin, and 2 students. In 2002, Office A started with about half the floor; however, it had gradually made spatial expansion as it grew. Two years ago, Office A finally took the entire floor, and Figure 2 shows the floor plan of Office A.

Overall Usage of the Floor Plan

Office A has five different neighborhoods (see *Figure 3*), which are Hamm, Summit, Lowry, Rice Park, and Landmark neighborhood. Additionally, there are various common areas: one front desk/lobby area, one restroom, two libraries, two kitchen/coffee areas, 10 conference rooms, one comfort room, one quiet/focus room, eight printing/plotting/scanning room, one vending machine, and two touchdown tables for small and quick meetings (See *Figure 3*).

According to previous literature on open offices, although the size and typology might be quite varied among the open-plan type offices via various environmental factors (e.g., the number of partitions, spatial density, openness, and architectural accessibility), open-plan offices are generally described as spaces having no walls or partitions between the workstations (Ashkanasy, Ayoko, & Jehn, 2014; Brennan, Chugh, & Kline, 2002; Oldham & Fried, 1987; Oldham & Rotchford, 1983). Therefore, Office A is categorized into an open office environment. The overall partitions between workstations that are facing each other are low, and there is no partition between workstations that are side by side. Except the Lowry neighborhood, all the partitions have the same style and height. In the Lowry neighborhood, the height of partitions is 1.44m (4'-8 1/2"). There is glass in the middle of the partition from 1.02m (3'-4") up to the top of the partition, so that employees are able to see each other very well. Outside the Lowry neighborhood, the rest of the partitions have two different heights since the partitions are a curved shape. The highest part is 1.83m (6'), and the lowest part is 1.07m (3'-6"). In addition, every workstation has a 1.02m (3'-4") high partition separating them from the aisles. Figure 4 and Figure 5 show the photos of the workstations with different height partitions.



1	Lobby	**7**	Vending	**13**	Conference 4	**19**	Conference 10	**25**	W Printer
2	Restroom	**8**	Comfort Room	**14**	Conference 5	**20**	Touchdown 1	**26**	N Printer
3	Library 1	**9**	Quite/Focus Room	**15**	Conference 6	**21**	Touchdown 2	**27**	S Printer
4	Library 2	**10**	Conference 1	**16**	Conference 7	**22**	IT	**28**	SE Printer
5	Kitchen 1	**11**	Conference 2	**17**	Conference 8	**23**	Plotting	**29**	Marketing Printer
6	Kitchen 2	**12**	Conference 3	**18**	Conference 9	**24**	E Printer	**30**	Scanning

Figure 3. A floor plan of Office A and space function

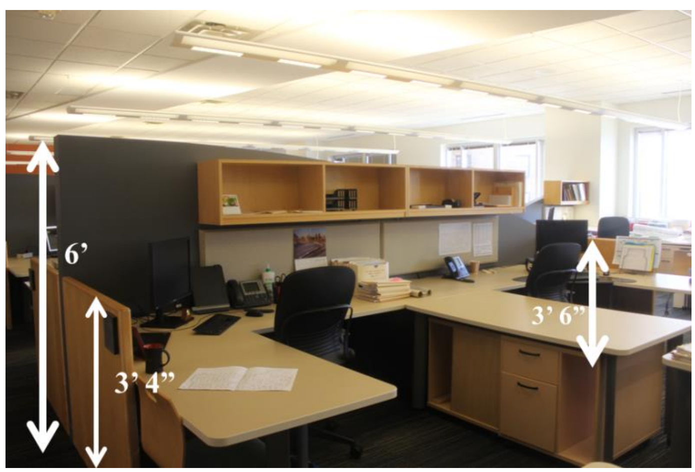


Figure 4. Workstations with different height partitions A

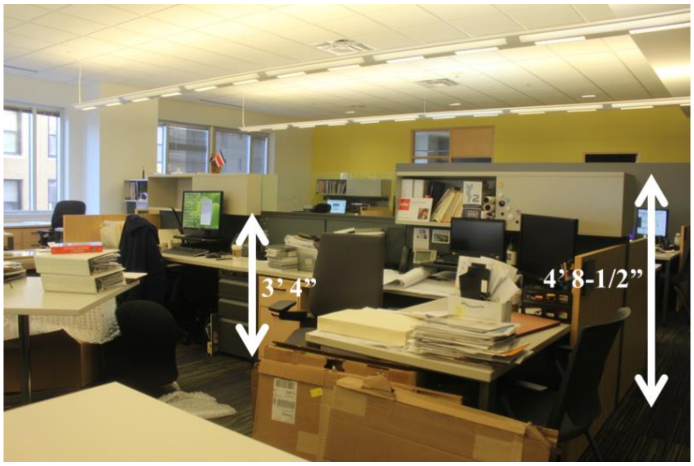
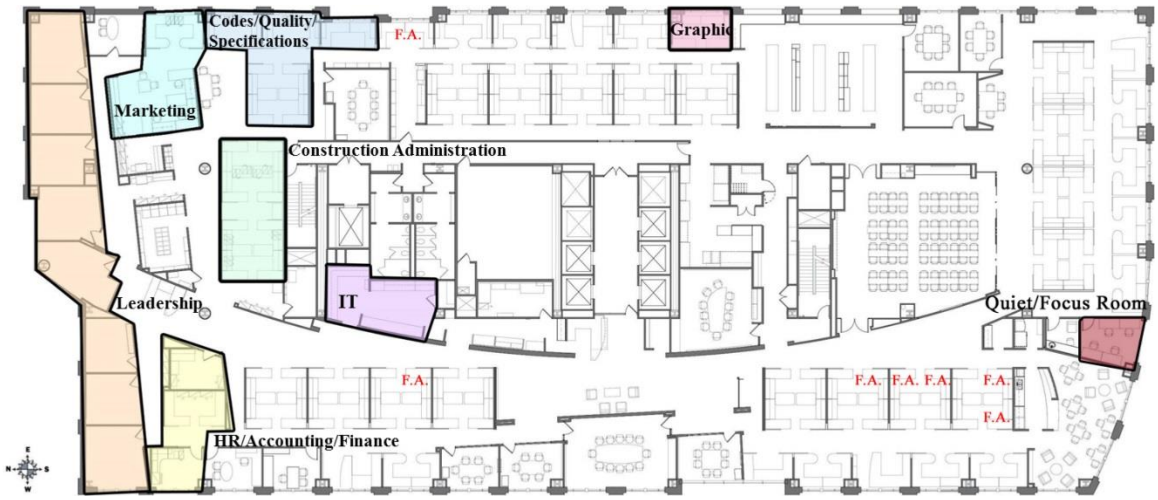


Figure 5. Workstations with different height partitions B

Unique Features

There are several unique features that Office A has. Each employee at Office A is usually assigned to a workstation based on what project he/she is working on. In other words, once a project that an employee is participating in is done and he/she starts to be involved in another project, he/she should relocate from the current workstation to a new workstation for the new project. If he/she is working on more than one project at the same time, the project he/she mainly works would be the location for his/her workstation. There are very few settled workstations zones which are for departments of marketing, codes/quality/specifications, graphics, construction administrations, IT, leadership, and HR/accounting/finance. Figure 6 highlights those areas having fixed workstations. This unique feature might imply that most interactions among coworkers occur in the same zones, since they are working on the same project.



Note. F.A. = Free address

Figure 6. Fixed workstations, quiet/focus room, and free addresses at Office A

As defined in the previous section, the existence of a quiet/focus room is one of the unique characteristics Office A has (see *Figure 6*). When an employee goes in the quiet/focus room, he/she will not be distracted. Since Office A has an open plan and one of the biggest disadvantages of the open plan is getting distracted from the noise, employees can put themselves into a closed environment. The quiet/focus room is free of noise such as other people's talking and announcements. By entering the quiet/focus room, they are able to concentrate on their work. Sometimes, people go to the quiet/focus room to make a personal phone call.

The last unique feature of Office A is that it is doing a pilot project, which is named free address. Free address is a same concept to *hot desk*, but a different name. *Hot-desking* is a trend newly applied to work environments to foster movement and interactions among workers. In a work environment using hot-desking, employees might not have any assigned desk to work at, but rather can occupy any vacant places for the day (Millward, Haslam, & Postmes, 2007). During the data collection, there were four people participating in free address. Two out of four people participated in this study. They sometimes chose a different workstation on different days, and sometimes changed their workstations during work hours on the same day. Out of total 140 workstations, there are seven available workstations (5%) for the people who were participating in free address (see *Figure 6*).

Statistical Analyses

The proposed hypotheses reflected in the model are analyzed by using R Studio. A linear mixed effect model, correlation, ANOVA, and *t*-test were used for this research. As one of the methods of regression, lmer (abbreviation of linear mixed effect regression) was a function in R for this analysis. The model generally explains the degree of an intercept and each variable's slope (how much impact the independent variable has on a dependent variable and whether that independent variable has positive or negative impact) with a consideration of random effect. A linear mixed model, including both fixed-effects for overall units and random-effects for an individual unit, has more flexibility of fitting in and could be extended for use in generalized linear mixed models (Bates, 2005). For this reason, a linear mixed effect model has been broadly used, especially in social and medical sciences, because it lets researchers investigate unexplained differences in the data by having random effects (Bates, 2005; Gelman & Hill, 2006; Snijders, 2011). For example, since most phenomena in social science are closely related with each other and controlling a specific variable completely from relationships is extremely challenging, it is hard to declare a precise relationship between variables. In those cases, many scientists point out possibilities of unexplained factors' impact, such as an individual's unique characteristics. Bates (2005) also states the following:

> A factor is repeatable if the set of possible levels of the factor is fixed and each of these levels is itself repeatable. In most studies, we would not regard patient identifier factor (or, more generally, the "subject" factor or any other factor representing an experimental unit) as being repeatable. Instead we regard the subjects in the study as a random sample from the population of interest. (p.27)

Using a linear mixed effect regression for this research has solid rationales. To begin with, distance and depth as independent variables should be fixed ones to investigate the potential influence on the number of steps and interactions. This research assumes that if the distance and/or depth are different, the following effects on the steps and interaction would be changed as well. Two participants engaging in the pilot project which is named free address do not have fixed workstations and one participant moved his/her workstation during the data collection period. As a consequence, the different distance and depth should be considered. In other words, their daily steps were regarded differently if they sit at different workstations. Both participants engaging in free address worked three different workstations during the data collection period, and the three different workstations each participant chose were identical. Therefore, for the mixed effect model, the self-reported data should be coded by the distance and depth and then be grouped by each individual person, instead of calculating the average of all of the self-report.

To put it simply, the data coded in this way is able to present the probable effects from other variables, such as the different daily work hours. It also implies the hidden difference within the same person. For example, the same person reported a wide range of numbers of steps and interactions during the data collection period, because it might be affected by his/her different daily work schedule. By contrast, the data having averages for steps and interactions does not provide enough information about the impact of the different distances and depths. This data can only imply each participant's overall tendency to walk and communicate with others during the period. However, with the data coded by day and grouped by participant, it is able to describe intimate relationships among the variables. For instance, the data is capable of discovering the effect on a participant's behavior pattern of steps and interaction if that participant sits at a different workstation one day from the other days. It might also point out better whether the number of steps would actually have an influence on the number of interactions or not, because the variables can be interpreted independently. Therefore, the data coded by day would fit better with the linear mixed model.

Furthermore, the linear mixed effect model contains random effect for the whole regression model, so the difference between participants would be considered. Even though the number of self-reports of each participant were varied, the model considered the participants as a random factor, and then calculated each participant's characteristics randomly. Consequently, the model was still effective even if there was the different number of self-reports from the different participant. Lastly, the model enables comparison of a data collected from the different groups or over time. That data would be called a non-nested group factor. However, because the participants were recruited and the data were collected within a single workplace, the data itself was regarded as a nested grouping factor.

In addition, correlation was used to test relationships among the variables discussed in this research. Correlation is widely used for two quantitative variables to be investigated if there is a relationship between the two (Lock, Lock, Morgan, Lock, & Lock, 2013). The result of the analyses indicates whether the variables have a positive or negative relationship and the degree of correlation among variables presented in the model. An analysis of the data proves if the original hypotheses are statistically supported or not. Importantly, correlation does not explain causation, but clarifies the relationship between variables. Correlation coefficient (r) between -1 and 1 represents strength and direction of linear relationships among variables (Lock et al., 2013). If a correlation coefficient is positive, it means that as independent variable increases, a dependent variable has a tendency to increase as well. The converse is true if a correlation coefficient is negative. In terms of the degree of strength of a linear relationship, the closer the number is to 0 can be interpreted as a weak relationship; on the other hand, the closer the number is to 1 can indicate a strong relationship. A moderate relationship can be explained with a coefficient value somewhere in the middle between 0 and 1. The boundaries among "weak," "moderate," and "strong" are subjective, and in social science, having correlations close to 0 is fairly common and 1 or near 1 for the correlation coefficient is uncommon (De Vaus, 2002).

For this research, correlation was used mostly to examine the relationships among distance, depth, steps, and interactions. Correlation was also used to find some influences (but not causal influences) of interactions on job satisfaction, and of habitual walking behavior and difficulty in walking on the number of steps. One type of data used for correlation was the averages of the numbers of steps and interactions per day by each participant during the data collection period. For example, the total number of steps reported for 10 business days was divided by the total number of self-reports itself. If a participant completed and reported seven self-report forms containing the information about the number of steps, interactions, and work hours, each seven days' steps were added together. Each seven days' work hours were added together as well. The sum of steps then was divided by seven, since he/she reported seven days. In addition to this, the number representing daily average was also divided by the number of daily work hours' average, and that number indicates hourly average value. It was further applied to examine correlations between the hourly averaged steps and interactions.

Interpreting correlation with the data having averages is appropriate because some of the variables are fixed values. For example, job satisfaction, habitual walking behavior, and having difficulty in walking do not change on a daily basis. Demographic information does not change either. These variables describe the participants' overall characteristics and opinions. Therefore, correlation should use data showing the overall tendency of walking and communicating with others by person.

Analysis of Variance (ANOVA) and *t*-tests were utilized to investigate the different groups' effect on the patterns of steps and interactions. *T*-tests and ANOVA, as an extension of the *t*-test, are the methods to assess whether the relationship between categorical independent variables and a quantitative dependent variable has statistical significance (Paul, 2005). The difference between a t-test and ANOVA is that a t-test is only able to compare up to two groups. However, ANOVA can see the difference of more than two groups. For this research, a t-test was used to explore the difference of gender, since gender was only categorized into two different groups. ANOVA was applied to study the groups' differences of age, work hours, and job titles.

Based on the methodology presented in this chapter, the following chapter provides the finding and results from the data collection for this research. The following chapter also discusses the major implications from the findings related to the hypotheses stated in Chapter 2.

CHAPTER 4: DATA ANALYSIS AND FINDINGS

Overview of Data Analysis

This chapter explores the findings from the data collected through self-reports and the questionnaire to find the impact of interior layout in a working environment on employees' behavior. The first part focuses on how the variables were defined for this research. The second part discusses the findings of the data analysis. By utilizing four different statistical methods, the relationships among the variables were found. After reviewing the overall summary of self-reports and the questionnaire the participants took, the degree and statistical significance of correlation between the variables will be discussed. In addition, the degree of impact of single and/or multiple variables on the variables of steps and interactions will be considered.

Measures

In order to explain the possible relationships among distance, steps, interaction, and job satisfaction, several variables were defined. Distance and depth were analyzed as the independent variables. The number of steps was regarded as a mediate variable to better explain the relation between distance and depth, and the number of interactions. The number of interactions and job satisfaction were measured as dependent variables in order to investigate a possible relationship. Since this research would be significantly affected by the participants themselves, the personal and organizational factors were considered as moderate variables, as indicated by the social ecological model (Grzywacz & Fuqua, 2000; Zimring et al., 2005). The strengthening or weakening of the relationships between the independent and dependent variables can be explained with the moderate variables. Gender, age, and years of working at the corporation were analyzed as personal factors, and the work schedule based on the hours worked each day and job title were collected as organizational factors.

Furthermore, Office A can be categorized as an open-space office, because the overall partition heights are closely similar, and no participant has his/her own private office in this research, even though there are people having their own private office. In addition, Office A was the only office recruited for the data collection, so comparing the findings with other office environments' can be done in future research. Therefore, the number of employees with private offices, which was discussed in the previous chapter as an environmental factor, was not addressed in this study.

Distance

The independent variable (distance between destinations) was calculated by analyzing the actual distance based on a floor plan. Based on the previous literature, people prefer to choose the shortest route (Seneviratne & Morrall, 1985; Weinstein Agrawal et al., 2008). The distance, which are based on the most common destinations in the office, was determined by a result from daily self-reports which showed the places participants frequently visit every day. On the daily self-reports, the participants were asked to report their destination and the path. The 12 most frequent zones were found by sorting each individual's self-report forms and examining frequency values of the ranked places each individual visited.

For each participant, the top destination was listed, with the most frequent destination being assigned 1, and the less frequent destination being assigned ascending numbers up to 11. Even though the total number of destinations all participants reported in their self-report forms was 30; the maximum number of places any one participant visited during the data collection period was 11. In other words, each participant's spectrum of the rank for frequently visited places could be varied, ranging from 1 to 11, from a whole list of 30 different destinations, with 1 as the most frequent destination. For example, the range of participant 2's (P2) frequent destinations was six. During two weeks, P2 visited the restroom most frequently, and vending area, conference room 3 and 9, touchdown table 1, and scanning area only one time. Therefore, the restroom was the top ranked place for P2; on the other hand, the five least frequent destinations were 6th ranked places. The places P2 never visited during the data collection were given zero, because only the places the participants did visit were considered.

To find out frequently visited places, a frequency value (a string of decreasing numbers from 11 to 1) and a string of zeros, replaced the ranks from 1 to 11 and a string of zeros. If a place ranked as a top, 11 frequency value (the most frequent place) was given, and if a place is ranked 5, 7 frequency values (the fifth frequent place) was given. For the places assigned zero that are unranked places, zero frequency value was given again because the place has not been visited by the participant for the data collection period. After replacing the ranks with the frequency value to each destination of each participant, all the frequency value was added.

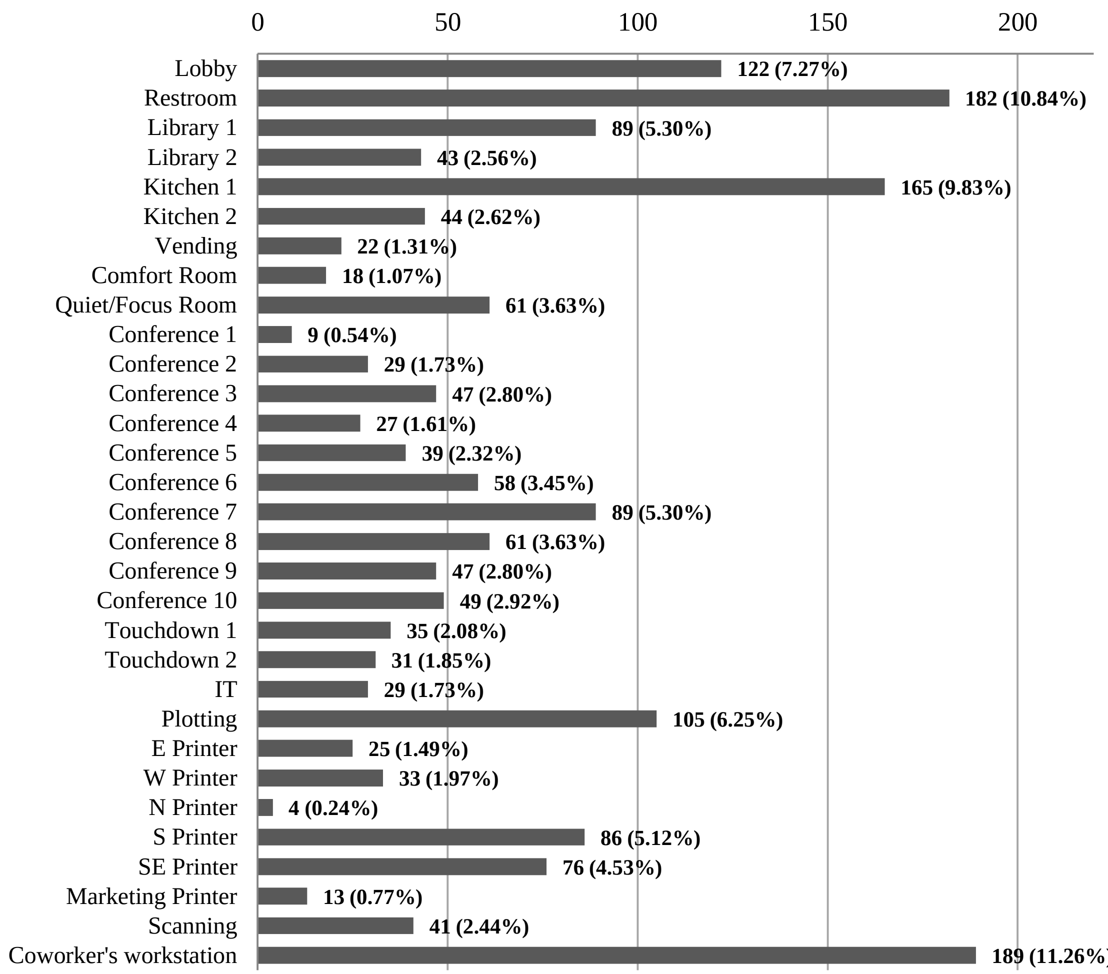


Figure 7. Frequency value and ratio to each destination

Note. The values in parentheses represent the ratio of the frequency value

Table 2.1

Rank and Frequency Value of Each Participant for Each Destination

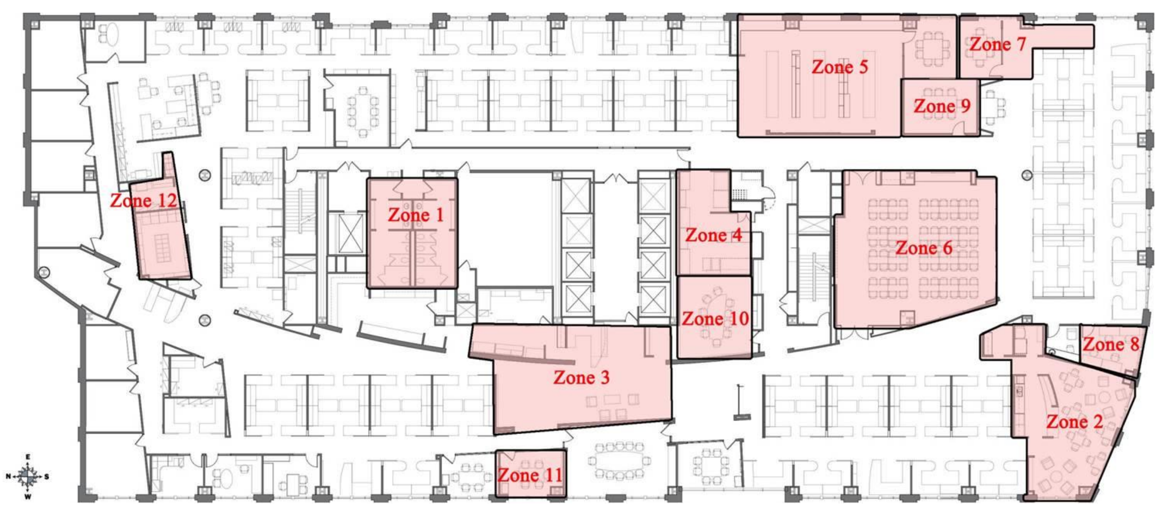
		Lobby	Restroom	Library 1	Library 2	Kitchen 1	Kitchen 2	Vending	Comfort Room	Quiet/focus Room	Conference 1	Conference 2	Conference 3	Conference 4	Conference 5
P1	Freq. Value	6	10	.	2	8	4	.	11	.	3	5	2	3	.
	Rank	6	2	.	10	4	8	.	1	.	9	7	10	9	.
P2	Freq. Value	9	11	7	.	9	.	6	.	.	.	.	6	.	7
	Rank	3	1	5	.	3	.	6	.	.	.	.	6	.	5
P3	Freq. Value	7	11	.	7	10	.	.	.	7	.	.	.	.	.
	Rank	5	1	.	5	2	.	.	.	5	.	.	.	.	.
P4	Freq. Value	5	9	.	.	8	5	.	.	6	.	.	5	10	.
	Rank	7	3	.	.	4	7	.	.	6	.	.	7	2	.
P5	Freq. Value	8	10	11	.	10	.	.	.	9	.	4	.	.	6
	Rank	4	2	1	.	2	.	.	.	3	.	8	.	.	6
P6	Freq. Value	6	9	.	.	11	.	6	.	.	.	.	.	.	7
	Rank	6	3	.	.	1	.	6	.	.	.	.	.	.	5
P7	Freq. Value	7	10	.	.	10	.	.	.	9	.	.	.	.	.
	Rank	5	2	.	.	2	.	.	.	3	.	.	.	.	.
P8	Freq. Value	8	11	.	6	10	7	.	.	.	.	6	.	.	.
	Rank	4	1	.	6	2	5	.	.	.	.	6	.	.	.
P9	Freq. Value	.	10	6	.	11	.	.	.	8	6	.	.	.	.
	Rank	.	2	6	.	1	.	.	.	4	6	.	.	.	.
P10	Freq. Value	5	8	9	.	11	.	4	.	.	.	.	.	6	.
	Rank	7	4	3	.	1	.	8	.	.	.	.	.	6	.
P11	Freq. Value	8	10	7	.	11	3	2	2	2	.	2	.	.	.
	Rank	4	2	5	.	1	9	10	10	10	.	10	.	.	.
P12	Freq. Value	7	11	.	4	9	6	.	.	.	.	.	5	.	.
	Rank	5	1	.	8	3	6	.	.	.	.	.	7	.	.
P13	Freq. Value	7	9	6	.	11	.	4	1	4	.	2	5	1	3
	Rank	5	3	6	.	1	.	8	11	8	.	10	7	11	9
P14	Freq. Value	11	9	8	.	.	7	.	.	.	.	7	6	7	.
	Rank	1	3	4	.	.	5	.	.	.	.	5	6	5	.
P15	Freq. Value	7	10	.	.	6	.	.	.	.	.	.	2	.	8
	Rank	5	2	.	.	6	.	.	.	.	.	.	10	.	4
P16	Freq. Value	7	11	.	.	10	.	.	.	.	.	.	.	.	.
	Rank	5	1	.	.	2	.	.	.	.	.	.	.	.	.
P17	Freq. Value	6	11	4	.	10	.	.	4	8	.	3	7	.	.
	Rank	6	1	8	.	2	.	.	8	4	.	9	5	.	.
P18	Freq. Value	7	11	7	.	10	.	.	.	8	.	.	9	.	8
	Rank	5	1	5	.	2	.	.	.	4	.	.	3	.	4
Sum of Freq. Value		121	181	65	19	165	32	22	18	61	9	29	47	27	39

Table 2.2

Rank and Frequency Value of Each Participant for Each Destination

		Conference 6	Conference 7	Conference 8	Conference 9	Conference 10	Touch down 1	Touch down 2	IT	Plotting	E Printer	W Printer	N Printer	S Printer	SE Printer	Marketing Printer	Scanning
P1	Freq. Value	2	6	.	.	.	.	.	7	9	.	10	.	.	.	.	.
	Rank	10	6	.	.	.	.	.	5	3	.	2	.	.	.	.	.
P2	Freq. Value	7	9	7	6	.	6	8	.	8	7	.	.	10	.	.	6
	Rank	5	3	5	6	.	6	4	.	4	5	.	.	2	.	.	6
P3	Freq. Value	7	.	.	.	7	8	.	.	.	7	.	.	7	9	.	7
	Rank	5	.	.	.	5	4	.	.	.	5	.	.	5	3	.	5
P4	Freq. Value	7	5	8	9	10	.	.	5	6	.	.	.	11	5	.	.
	Rank	5	7	4	3	2	.	.	7	6	.	.	.	1	7	.	.
P5	Freq. Value	7	4	3	5	.	.	4	.	6	.	.	.	3	8	.	.
	Rank	5	8	9	7	.	.	8	.	6	.	.	.	9	4	.	.
P6	Freq. Value	.	6	5	.	.	.	.	.	8	.	.	.	10	.	4	.
	Rank	.	6	7	.	.	.	.	.	4	.	.	.	2	.	8	.
P7	Freq. Value	.	7	7	.	8	7	.	.	9	.	.	.	.	11	.	.
	Rank	.	5	5	.	4	5	.	.	3	.	.	.	.	1	.	.
P8	Freq. Value	.	7	.	.	.	.	.	.	7	.	.	.	.	.	9	.
	Rank	.	5	.	.	.	.	.	.	5	.	.	.	.	.	3	.
P9	Freq. Value	.	7	.	6	.	.	7	.	.	.	9	.	.	.	.	6
	Rank	.	5	.	6	.	.	5	.	.	.	3	.	.	.	.	6
P10	Freq. Value	3	.	5	6	7	5	.	4	3	.	4	.	4	10	.	3
	Rank	9	.	7	6	5	7	.	8	9	.	8	.	8	2	.	9
P11	Freq. Value	4	5	2	2	.	5	.	6	4	2	.	.	.	9	.	.
	Rank	8	7	10	10	.	7	.	6	8	10	.	.	.	3	.	.
P12	Freq. Value	8	8	6	.	5	4	5	7	4	.	.	.	.	10	.	.
	Rank	4	4	6	.	7	8	7	5	8	.	.	.	.	2	.	.
P13	Freq. Value	4	2	2	3	.	.	.	.	8	.	.	2	10	.	.	1
	Rank	8	10	10	9	.	.	.	.	4	.	.	10	2	.	.	11
P14	Freq. Value	.	6	.	.	.	.	.	.	5	.	10	.	.	.	.	7
	Rank	.	6	.	.	.	.	.	.	7	.	2	.	.	.	.	5
P15	Freq. Value	.	5	3	.	.	.	.	.	9	.	.	.	11	.	.	4
	Rank	.	7	9	.	.	.	.	.	3	.	.	.	1	.	.	8
P16	Freq. Value	.	.	6	.	.	.	.	.	8	9	.	.	.	.	.	.
	Rank	.	.	6	.	.	.	.	.	4	3	.	.	.	.	.	.
P17	Freq. Value	2	5	7	2	3	.	.	.	4	.	.	2	9	6	.	.
	Rank	10	7	5	10	9	.	.	.	8	.	.	10	3	6	.	.
P18	Freq. Value	7	7	.	8	9	.	7	.	7	.	.	.	11	8	.	7
	Rank	5	5	.	4	3	.	5	.	5	.	.	.	1	4	.	5
Sum of Freq. Value		58	89	61	47	49	35	31	29	105	25	33	4	86	76	13	41

Table 2.1 and 2.2 show both the rank and frequency value of each participant. Figure 7 shows the sum of each frequency value, and based on the figure, restroom, kitchen, lobby, library, and plotting/printing area have high frequency value. As stated in the reports, the 12 most frequently visited zones were identified as well. Places with a frequency value higher than 40 were used to define zones, and adjacent places categorized into a same zone. Figure 8 describes 12 different zones in the floor plan, and explains the zones below the plan. Therefore, the sum of each distance between the participant's workstation and the 12 different zones were used to identify distance for each participant. Table 3 summarizes each of the participant's distance used for this research.



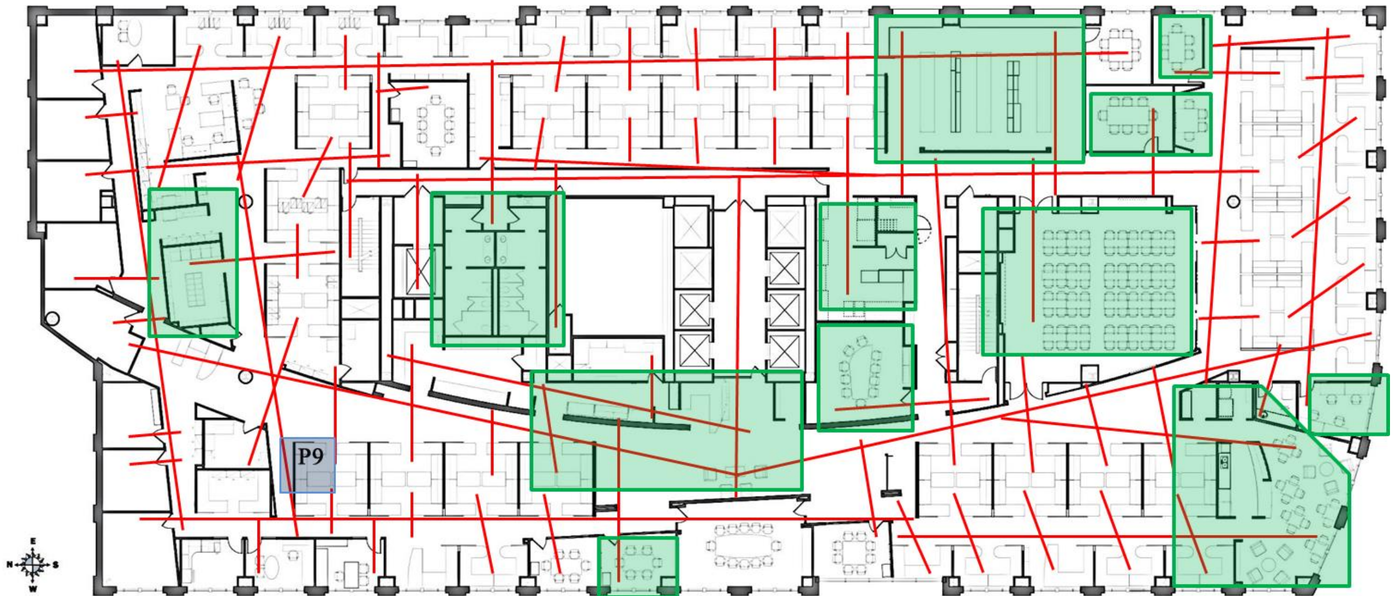
Zone 1	Restroom	**Zone 7**	SE Printer + Conference 10
Zone 2	Kitchen 1 + S Printer	**Zone 8**	Quiet/Focus Room
Zone 3	Lobby + Scanning	**Zone 9**	Conference 8
Zone 4	Plotting	**Zone 10**	Conference 6
Zone 5	Library 1 + Conference 9	**Zone 11**	Conference 3
Zone 6	Conference 7	**Zone 12**	Kitchen 2 + Library 2

Figure 8. The 12 frequently visited zones in the floor plan

Depth

Depth, which is one of the constructs based on the space syntax theory, was established by analyzing the floor plan. Depth is closely related to path length. As it is defined in Chapter 2, depth explains a degree or the number of spaces people have to pass through from one space to a destination. The axial lines connect the spaces to pass through. For example, if a person needs to follow five axial lines from his/her workstation to a destination, such as a printer room, there would be five different spaces to pass through and the depth would be five from the workstation to the printer room. Because spaces are not equal in size, the greater degree of depth does not necessarily mean that the place is farther away than a place having smaller degree.

The 12 zones (see *Figure 8*), which were used to determine the distance earlier and were the most frequently visited places in the office, were applied to find out depth as well. Each depth between every participant's workstation and the 12 different destination zones in the office was analyzed, and the depth for this research was the sum of the 12 depths. Because depth is greatly dependent on axial lines, if a workstation shares the same line with another workstation, their depth would be same. In other words, if there are workstations on the same axial line, the depth would be identical, even though the workstations are not located next to each other. Figure 9 describes the way to measure depth from a workstation to each destination, as an example of Participant 9. Figure 9 shows depth from the participants' workstations. Table 3 also summarizes each value of distance and depth from the each participant's workstation.



Destination	Distance (m)	Depth
Zone 1	39.48	6
Zone 2	64.49	3
Zone 3	31.82	2
Zone 4	55.96	4
Zone 5	55.37	4
Zone 6	51.81	3
Zone 7	79.59	5
Zone 8	67.75	4
Zone 9	78.55	4
Zone 10	48.81	4
Zone 11	21.13	2
Zone 12	19.18	3
Total	**617.95**	**44**

Figure 9. The way to measure depth from P9's workstation to each destination

Table 3

Each Value of Distance and Depth from the Each Participant's Workstation

		Distance (m)	Depth
P1		510.80	51
P2		511.15	52
P3		544.92	55
P4		496.11	55
P5	**1**	426.11	42
	2	355.77	34
	3	356.43	34
P6		444.60	52
P7		580.34	55
P8	**1**	758.80	49
	2	425.26	49
P9		617.95	44
P10		373.22	35
P11		531.18	55
P12		580.43	55
P13		449.50	52
P14		545.09	53
P15		415.41	52
P16		378.65	49
P17	**1**	426.11	42
	2	355.77	34
	3	356.43	34
P18		422.97	54

Number of Steps

Participants' number of steps were measured daily from when they arrived at work to when they left the office. They were instructed to put the pedometers on their waist, such as on their belts or pants and not in their pockets, to improve the accuracy. The data for this research was identified by the participants by self-reporting the daily recorded as number of steps on the pedometers. Both correlation and a linear mixed effect model were used to statistically analyze the relationships of the number of steps to other variables. For a linear mixed effect model, raw data of the number of steps was studied; for correlation, the average of the number of steps per person was used.

Number of Interactions

Participants were asked to draw a star on the self-report form whenever they had face-to-face interaction with coworkers. The degree of interaction was measured from the result of the self-report. As described earlier, the variable of interaction was also analyzed as an average as well as raw data through two different methods. An average during the data collection period of each participant's interaction was examined for finding correlation, and the raw data was used for the linear mixed effect model.

Satisfaction

Participants were asked about their job satisfaction in three different categories: motivational, social, and contextual characteristics. The part of job satisfaction which is the most closely related to interaction is the social characteristic. However, because each characteristic of job satisfaction is closely related, all three of them were analyzed to see the correlation with the number of interactions.

Results

Survey Results

For this research, data were collected from 18 participants through completing self-reports and the questionnaire. The overall results of the data are summarized in Table 4 and Table 5. Table 4 shows the demographic information and Table 5 describes the participants' response to the questions regarding their three different job satisfaction characteristics (motivational, social, and contextual characteristics), habitual walking behavior, and difficulty in walking.

Table 4

Demographic Information

Variables	**Response**	
	N	***%***
Gender		
Male	6	33
Female	12	67
Age		
18-25 yr-old	1	6
26-35 yr old	10	56
36-45 yr old	7	73
46-55 yr old		.
56 yr old or more		.
Years of working at the corporation		
Up to 2 years	3	17
2-5 years	5	28
6-10 years	6	33
11-20 years	4	22
21-30 years		.
More than 30 years		.
Job Title		
Project Manager	4	22
Project Architect	7	39
Interior Designer	3	17
Design Researcher	1	6
Marketing	1	6
Design Leader	1	6
Intern	1	6

Originally, nine social, eight motivational, and five contextual characteristics for job satisfaction questions and six questions about habitual walking behavior were asked. Before analyzing the data, Cronbach's alpha reliability test was conducted to see how much internal consistency the questions had under the same categories. As the reliability can be determined by a test itself, internal consistency reliability is useful to evaluate the degree of correlation among each question to measure the same concepts (Gliem & Gliem, 2003; Tavakol & Dennick, 2011). Cronbach's alpha reliability (α) is normally expressed by a number ranging from 0 to 1, and the closer number to 1 represents the greater internal consistency. The acceptable values of reliability have been reported in diverse ranges from 0.7 to 1 (Darren & Mallery, 1999; Gliem & Gliem, 2003; Tavakol & Dennick, 2011; Yildirim, Akalin-Baskaya, & Celebi, 2007). According to Darren and Mallery (1999), an alpha value between 0.9 and 1 is excellent, between 0.8 and 0.89 is good, and between 0.7 and 0.79 is acceptable.

After conducting the reliability test, only three social, six motivational, and two contextual characteristics showed high reliability between each question; hence, those questions were selected to be analyzed further. In terms of habitual behavior, the whole set of questions showed fairly high reliability; therefore, all six questions' responses were examined. As Table 5 describes each characteristic's and concept's reliability and all numbers are higher than 0.7, so the questions may be considered as reliable.

Table 5 also summarizes the analysis based on the responses to the questionnaire. Each mean and standard deviation for each question was calculated, and the mean and standard deviation about the average of the questions for the same concepts were also provided. The values in parentheses represent standard deviation. According to the results in Table 5, the participants' overall job satisfaction is high, because the majority of responses are greater than 3, and the average is higher than 3.5 out of 5 point scale. They reported that they have a tendency to walk habitually and that they are unlikely to have difficulty in walking.

Table 5

Survey Results

Social Characteristics of Job Satisfaction		Response	Mean(SD)	Ave. Mean (SD)	Reliability
I receive a great deal of information from my manager and co-workers about my job performance	Strongly Disagree	1(6%)	3.278 (.958)		
	Disagree	2(11%)			
	Neither Agree Nor Disagree	7(39%)			
	Agree	7(39%)			
	Strongly Agree	1(6%)			
Other people in the organization, such as managers and co-workers, provide information about effectiveness (e.g., quality and quantity) of my job performance.	Strongly Disagree	.	3.5 (.707)	3.407 (.754)	.871
	Disagree	1(6%)			
	Neither Agree Nor Disagree	8(44%)			
	Agree	8(44%)			
	Strongly Agree	1(6%)			
I receive feedback on my performance from other people in my organization (such as my manager or co-workers).	Strongly Disagree	.	3.44 (.856)		
	Disagree	3(17%)			
	Neither Agree Nor Disagree	5(28%)			
	Agree	9(50%)			
	Strongly Agree	1(6%)			
Motivational Characteristics of Job Satisfaction		**Response**	**Mean(SD)**	**Ave. Mean (SD)**	**Reliability**
The job requires me to monitor a great deal of information.	Strongly Disagree	.	4.556 (.616)		
	Disagree	.			
	Neither Agree Nor Disagree	1(6%)			
	Agree	6(33%)			
	Strongly Agree	11(61%)			
The job requires unique ideas or solutions to problems.	Strongly Disagree	.	4.667 (.485)		
	Disagree	.			
	Neither Agree Nor Disagree	.			
	Agree	6(33%)			
	Strongly Agree	12(67%)			
The job requires me to utilize a variety of different skills in order to complete the work.	Strongly Disagree	.	4.444 (.511)	4.37 (.456)	.844
	Disagree	.			
	Neither Agree Nor Disagree	.			
	Agree	10(56%)			
	Strongly Agree	8(44%)			
The job requires me the performance of a wide range of tasks.	Strongly Disagree	.	4.389 (.502)		
	Disagree	.			
	Neither Agree Nor Disagree	.			
	Agree	11(61%)			
	Strongly Agree	7(39%)			
The job requires very specialized knowledge and skills.	Strongly Disagree	.	4.333 (.485)		
	Disagree	.			
	Neither Agree Nor Disagree	.			
	Agree	12(67%)			
	Strongly Agree	6(33%)			
The job provides me the	Strongly Disagree	.	3.833		

chance to completely finish the pieces of work I begin.	Disagree	1(6%)	(.924)		
	Neither Agree Nor Disagree	6(33%)			
	Agree	6(33%)			
	Strongly Agree	5(28%)			

Contextual Characteristics of Job Satisfaction		**Response**	**Mean(SD)**	**Ave. Mean (SD)**	**Reliability**
The seating arrangements on the job are adequate (e.g., ample opportunities to sit, comfortable chairs, good postural support).	Strongly Disagree	.	3.722 (.575)	3.5 (.594)	.731
	Disagree	1(6%)			
	Neither Agree Nor Disagree	3(17%)			
	Agree	14(78%)			
	Strongly Agree	.			
The workplace allows for all different size for people in terms of clearance, reach, eye height, leg room, etc.	Strongly Disagree		3.278 (.752)		
	Disagree	3(17%)			
	Neither Agree Nor Disagree	7(39%)			
	Agree	8(44%)			
	Strongly Agree	.			

Habitual Walking Behavior		**Response**	**Mean(SD)**	**Ave. Mean (SD)**	**Reliability**
Physical activity is something I do frequently.	Strongly Disagree	1(6%)	3.5 (.985)	3.5 (.836)	.929
	Disagree	2(11%)			
	Neither Agree Nor Disagree	3(17%)			
	Agree	11(61%)			
	Strongly Agree	1(6%)			
Physical activity is something I do automatically.	Strongly Disagree	1(6%)	3.5 (.985)		
	Disagree	3(17%)			
	Neither Agree Nor Disagree	.			
	Agree	14(78%)			
	Strongly Agree	.			
Physical activity is something I do without having to consciously remember.	Strongly Disagree	1(6%)	3.5 (1.097)		
	Disagree	3(17%)			
	Neither Agree Nor Disagree	1(6%)			
	Agree	12(67%)			
	Strongly Agree	1(6%)			
Physical activity is something I do without thinking.	Strongly Disagree	1(6%)	3.444 (1.043)		
	Disagree	4(22%)			
	Neither Agree Nor Disagree	.			
	Agree	12(67%)			
	Strongly Agree	1(6%)			
Physical activity is something that belongs to my (daily, weekly, monthly) routine.	Strongly Disagree	.	3.444 (.784)		
	Disagree	3(17%)			
	Neither Agree Nor Disagree	4(22%)			
	Agree	11(61%)			
	Strongly Agree	.			
Physical activity is something I start doing before I realize I am doing it.	Strongly Disagree	.	3.611 (.916)		
	Disagree	3(17%)			
	Neither Agree Nor Disagree	3(17%)			
	Agree	10(56%)			
	Strongly Agree	2(11%)			

Difficulty in Walking		Response	Mean(SD)	Ave. Mean (SD)	Reliability
I have no difficulty in walking.	Strongly Disagree	1(6%)	4.556 (.984)	.	.
	Disagree	.			
	Neither Agree Nor Disagree	.			
	Agree	4(22%)			
	Strongly Agree	13(72%)			

Note. SD=Standard Deviation, Values in parentheses under response are ratio and values in parentheses under mean are standard deviations.

Self-reports Results

Most self-report data were collected between Feb 9th and Feb 20th, 2015, because the participants were instructed to report their data for ten business days. However, because the participants' work schedule was varied, several additional self-reports were therefore collected by Mar 3rd. The total number of self-reports collected was 133, and the average number of self-reports by each participant was 7.39.

Table 6 describes the average of the number of steps and interactions, and the average number of the hours worked per day for the data collection period. All numbers showing the averages, except work hours per day, in Table 6 are rounded up to the nearest one.

Table 6

Self-Report Results

	Steps	Interactions	Work Hours
P1	1,769	21	7.85
P2	3,170	10	8.17
P3	1,880	16	8.80
P4	1,164	11	6.81
P5	1,776	17	6.78
P6	1,347	4	6.14
P7	685	8	7.72
P8	4,335	7	8.92
P9	2,645	14	7.50
P10	3,090	15	8.06
P11	2,322	13	7.44
P12	788	20	7.81
P13	936	14	6.52
P14	1,780	27	8.58
P15	881	3	8.33
P16	1,913	4	8.57
P17	2,102	17	7.94
P18	587	15	5.00

Findings

In this section, the statistical findings from data analysis explaining the hypotheses raised for this research will be discussed. Based on the result from Table 5 and Table 6, Table 7 shows the overall correlations from the average data about depth, distance, steps, total interactions, and work hours. The values in parentheses represent the p-value for the degree of significance about the correlations. According to Table 7, there is a strong positive correlation between distance and depth. However, steps and depth have a negative relationship, while steps and distance have a positive one. Depth and interactions also have a negative correlation. Between steps and hours, there is a strong positive correlation; however, surprisingly there is a very weak correlation between hours and interactions.

Table 7

Correlations Among Depth, Distance, Steps, Interactions, and Work Hours with the Average Data

	Depth	**Distance**	**Steps**	**Interactions**
Depth				
Distance	0.58 (.004)			
Steps	-0.23 (.282)	0.29 (.18)		
Interactions	-0.3 (.166)	-0.1 (.634)	-0.06 (.777)	
Work Hours	0.04 (.857)	0.22 (.309)	0.53 (.009)	0.09 (.669)

Note. Values in parentheses are p-values.

Before going deeper into discussion on the relationships among and effects of each variable, it is important to understand the huge variance in the participant's own characteristics that might greatly influence subsequent results. Figure 10 and Figure 11 show that diversity thoroughly. Figure 10, showing daily record about the number of steps and interactions, is a scatter diagram and each dot represents an individual self-report. It has a positive relationship; however, most dots are scattered widely. On the other hand, Figure 11 is showing each scatter diagram, by participant, based on the correlation between steps and interactions. The scatter diagrams basically illustrate how an individual's correlation is varied from the others. The dots are not scattered widely unlike Figure 10, and the locations of the dots' group are quite diverse. The diagrams also show more strong correlations than a diagram in Figure 11. These facts imply that the variables, steps and interactions, are notably affected by participant's individual differences; hence, using a linear mixed model dealing with participants' random effect to analyze further makes much more sense for this research.

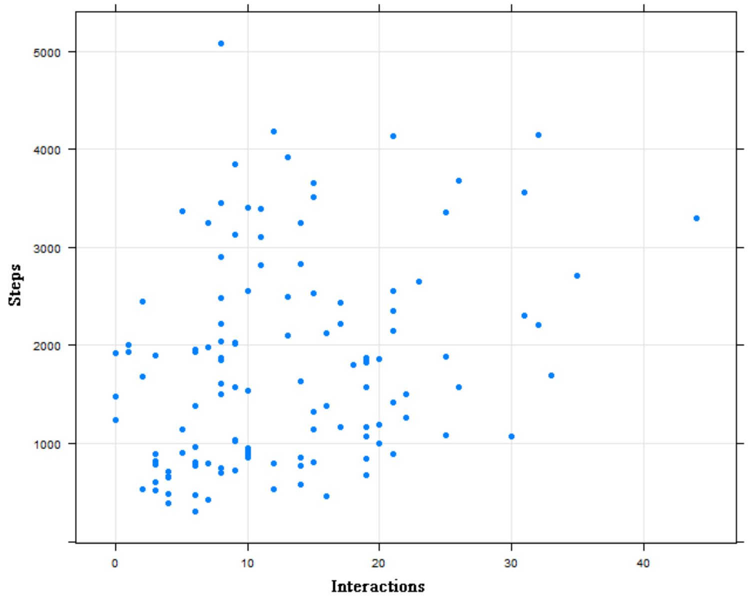


Figure 10. A scatter diagram showing daily record about the number of steps and interactions

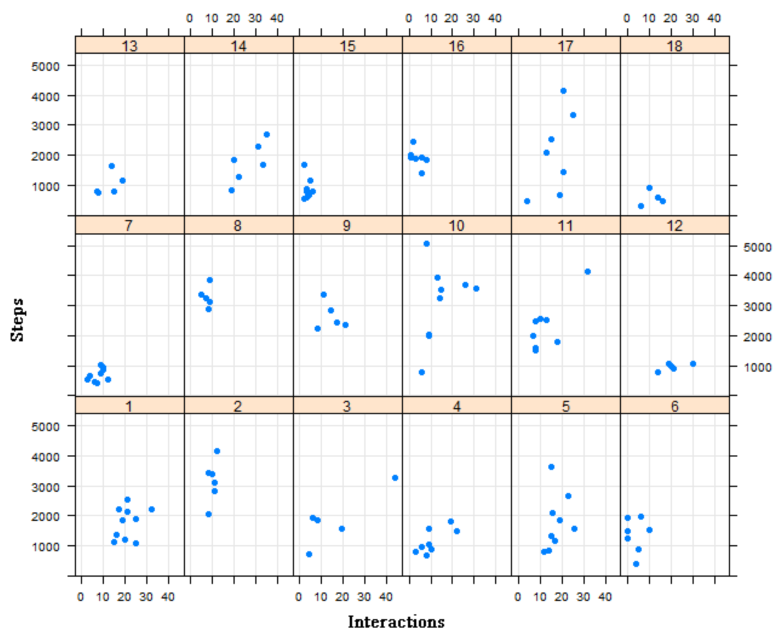


Figure 11. Scatter diagrams showing each participant's correlation between steps and interactions

From this perspective, Table 8, using a daily reported data, summarizes the same correlations explained in Table 7; however, the result is quite different. For example, there were positive relationships between interactions and distance and between interactions and steps. In addition, a positive relationship between hours and interactions was found.

The variables are identical, but the only difference between the two tables is the data used. Most p-values, telling the statistical significance about the degree of correlations, are higher than the ones in Table 8 because it contains a large quantity of data. In addition, since Table 8 shows daily correlations rather than the overall tendency unlike Table 7, those correlations are more efficient to show the possible relationship between the daily different steps and interactions. For this reason, this data which was coded by day was used for the data analyses of linear mixed effect models. Another main difference between two tables is that some variables, such as distance and depth, got different correlation compared to Table 7, even though they are the fixed ones. This is caused by the fact that the number of self-reports submitted for the data collection varied from person to person.

Table 8

Correlations among Depth, Distance, Steps, Interactions, Work Hours with the Data Coded by Day and Grouped by Participants

	Depth	**Distance**	**Steps**	**Interactions**
Depth				
Distance	0.63 (.000)			
Steps	-0.35 (.000)	-0.11 (.236)		
Interactions	-0.14 (.109)	0.21 (.021)	0.29 (.001)	
Work Hours	-0.03 (.766)	0.11 (.234)	0.42 (.000)	0.28 (.002)

Note. Values in parentheses are p-values.

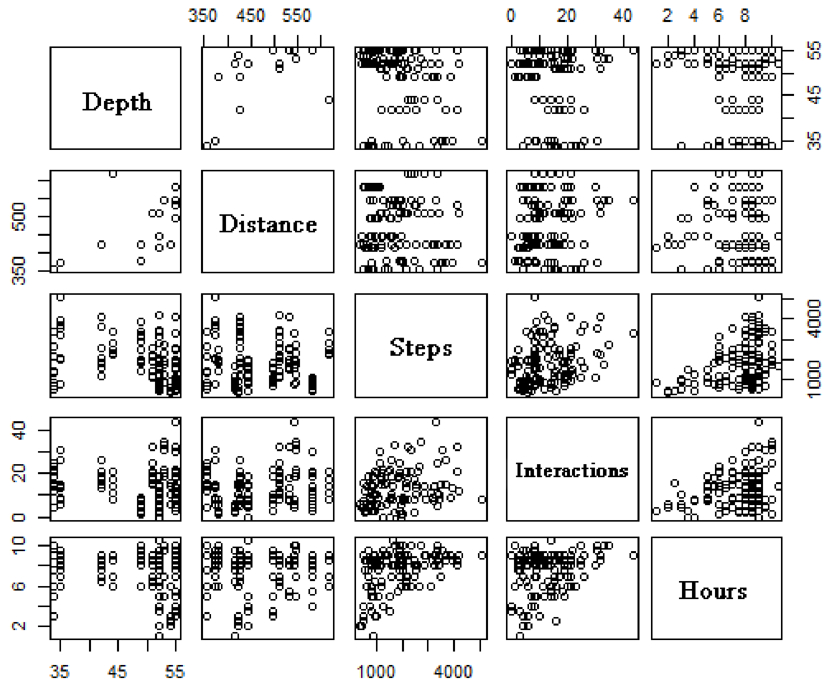


Figure 12. Scatter diagrams showing correlations among depth, distance, steps, interactions, and work hours

Therefore, using the linear mixed effect model considering the random effect of participants was well fitted into analyzing the data for this research. Figure 12 shows the correlations with the scatter diagrams of five variables in Table 8.

Distance, Depth, and Steps

First of all, the effects of distance and/or depth on the number of steps were analyzed. Three different linear regression models with a random effect of the participants were developed to discover each effect on steps. According to the mixed effect models, distance and depth of their workstations simultaneously had influence on the number of steps they walked. As Table 9 describes, distance had a positive relationship for determining the number of steps, and depth had a negative correlation with steps. Since an absolute t-value determines statistical significance, both slopes of distance (*p*=.010) and depth (*p*=.015) to covary the numbers of steps are statistically significant (see Table 9). An initial intercept and the each slope for an equation can be found in Estimate column in Table 9. The equation for this mixed effect regression is as followings:

$$Steps = 2787.12 + 7.55*Distance + (-91.26)*Depth$$

To calculate the number of steps with this equation, the given degree of distance and depth should be substituted into the formula.

On the other hand, distance (p=.180) and depth (p=.282) did not separately have statistically significant correlations with the number of steps. Even though there was a correlation with a highly significant statistic value between depth and the number of steps, there was a non-significant slope of depth for the number of steps. This might have happened because several different workstations have the same degree of depth but at the same time the number of steps would be greatly affected by participants' individual differences.

Table 9

Three Linear Mixed Effect Models for the Each Effect of Distance and/or Depth on the Number of Steps

	Estimate	**SD. Error**	**t-value**	**P-value**
Intercept	477.66	1197.14	0.35	.731
Distance	3.44	2.48	1.38	.180
Intercept	3720.26	1543.24	2.41	.025 *
Depth	-35.55	32.21	-1.10	.282
Intercept	2787.12	1376.68	2.03	.056 .
Distance	7.55	2.67	2.83	.010 *
Depth	-91.26	34.15	-2.67	.015 *

Note. SD=Standard Deviation, '.' p<.1, * p<.05, ** p<.01, *** p<.001

Table 10 shows distance and the additional moderate variables' potential effects on the number of steps. The moderate variables used for this linear model were gender, age, years of working in the corporation, job title, and work hours. Because those variables, excluding work hours, were coded as categorical values instead of quantitative ones, the responses from the categorical questions should not be weighted when analyzing the data with a linear mixed effect model (e.g., 1 for gender means male, 2 for gender means female, 1 for age means 18-25 years old, and etc.). For this reason, the moderate variables were analyzed as factors which were not weighted in the model according to the numbers assigned for the answers. The fixed standard answers for each question were the first answers, which were coded as "1" for each question. For example, for regarding gender, "1" was assigned "male", and for job title questions, project manager was given "1". Thus, the answers for each question, except the first answer, were listed in Table 10 and the following tables, showing the linear mixed effect models. According to Table 10, distance had a positive correlation with the number of steps, and the degree of the slope was statistically significant (p=.029). Furthermore, the participants who have been working at the corporation for 11-20 years differed in the number of steps with those who have been working at Office A less than two years, and the relationship was statistically supported. In addition, the participants who are interior designers or in the marketing department differed in the number of steps with those working as project managers. Work hours also had statistically significant differences in steps (p=0.012).

Based on the linear effect model (see Table 10), ANOVA test (see Table 11) was conducted to see how much each variable has influence on the number of steps accompanying with the effect of distance. Referring to Table 11, all the moderate variables show that differences existed among the groups such as gender, age, and years of working, when the model was considering the effect of distance on the number of steps.

In other words, each variable had a relationship with the steps. The model itself explained that different distance had an influence on walking more or less, and it is greatly supported statistically (*p*=.019). The difference between genders was marginally supported (*p*=.056), and the rest of the differences among the groups were supported by statistical significance (see Table 11). The appropriate equation for the mixed effect regression is as followings:

Step = -3525.56 + 5.05*Distance + (-353.34)*Female+222.93*Age: 26-35 yr +(-364.55)*Age: 36-45 yr+(-241.87)*Y of W:2-5 yr+(-1342.85)*Y of W: 6-10 yr +(-1342.85)*Y of W: 11-20 yr+557.24*JT:PA +1954.19*JT:ID + 1578.8*DR + 1999.19*JT: MT+ 2212.4*JT: DL+453.81*Work Hours

Note. Y of W=Years of Working, JT=Job Title, PA=Project Architect, ID=Interior Designer, DR=Design Researcher, MT=Marketing, DL=Design Leader

Table 10

A Linear Mixed Effect Model for the Effects of Distance, Gender, Age, Years of Working, Job Title, and Work Hours on the Number of Steps

	Estimate	SD. Error	t-value	P-value
Intercept	-3525.56	1769.39	-1.99	.077 .
Distance	5.05	1.94	2.60	.029 *
Gender: Female	-353.340	413.74	-0.85	.415
Age: 26-35 yr	222.93	1126.28	0.20	.847
Age: 36-45 yr	-364.55	776.10	-0.47	.650
Y of W.: 2-5 yr	-241.87	954.62	-0.25	.805
Y of W: 6-10 yr	-1153.50	816.22	-1.41	.191
Y of W: 11-20 yr	-1342.85	555.56	-2.42	.039 *
JT: Project Architect	557.24	537.89	1.04	.326
JT: Interior Designer	1954.19	612.43	3.19	.011 *
JT: Design Researcher	1578.80	1043.63	1.51	.164
JT: Marketing	1999.19	790.66	2.53	.032 *
JT: Design Leader	2212.40	1166.47	1.90	.090 .
JT: Intern	-	-	-	-
Work Hours	453.81	145.37	3.12	.012 *

Note. Y of W=Years of Working, JT=Job Title, SD=Standard Deviation, '.' p<.1, * p<.05, ** p<.01, *** p<.001

Table 11

ANOVA test for the Effects of Distance, Gender, Age, Years of Working, Job Title, and Work Hours on the Number of Steps

	Df	Sum Sq.	Mean Sq.	F-value	P-value
Distance	1	2723775	2723775	8.15	.019 *
Gender	1	1600060	1600060	4.79	.056 .
Age	2	6584224	3292112	9.85	.005 **
Years of Working	3	6769627	2256542	6.75	.011 *
Job Title	5	8581417	1716283	5.14	.016 *
Work Hours	1	3255035	3255035	9.74	.012 *
Residuals	9	3006119	334013		

Note. Y of W=Years of Working, JT=Job Title, Df=Degree of Freedom, '.' p<.1, * p<.05, ** p<.01, *** p<.001

To calculate the number of steps with this equation, the given amount for distance and work hours should be substituted into the formula. Regarding the categorical variables which are gender, age, years of working, and job title, "1" should be assigned to a subcategory which can be applied to the participant, and "0" will be assigned to rest of the subcategories. For example, if the participant is 30 years old male and has been working at the corporation in 5 years as an interior designer, only "Age: 26-35 yr", "Y of W: 2-5 yr", and "JT: ID" should be assigned with "1", at the same time, rest of the subcategories should be assigned with "0".

The two tables (see Table 12 and Table 13) summarize the findings of the same variables with only the replacement of distance with depth on the number of steps. However, the result with this model was slightly changed when compared to the previous model considering the effect of distance. Work hours showed the differences in the number of steps with statistical significance (p=.041). The difference between the participants in marketing position and project management had also statistically significant support in the differences (*p*=.052).

Table 13 illustrates that differences were found among the heterogeneous groups of age, years of working, job title, and the amount of work hours, albeit Table 12 shows the differences in only two subcategories. The reason for that is Table 12 explains the differences between the standard group of each variable and the other subgroup with in the same variable. With consideration of depth's meaning on the number of steps, age (*p*=.031), years of working at the corporation (*p*=.037), and work hours (*p*=.041) are affective to the number of step with statistically significance, and job title (*p*=.072) has moderate impact on that.

Table 12

A Linear Mixed Effect Model for the Effects of Depth, Gender, Age, Years of Working, Job Title, and Work Hours on the Number of Steps

	Estimate	SD. Error	t-value	P-value
Intercept	-1531.14	2832.69	-0.54	.602
Depth	22.69	48.93	0.46	.654
Gender: Female	-226.69	537.06	-0.42	.693
Age: 26-35 yr	-513.05	1470.50	-0.35	.735
Age: 36-45 yr	-1103.57	1053.12	-1.05	.322
Y of W.: 2-5 yr	-230.37	1258.63	-0.18	.859
Y of W: 6-10 yr	-980.23	1067.69	-0.92	.322
Y of W: 11-20 yr	-1302.04	799.70	-1.67	.129
JT: Project Architect	240.69	685.35	0.35	.733
JT: Interior Designer	1412.03	984.27	1.43	.185
JT: Design Researcher	933.34	1323.16	0.70	.498
JT: Marketing	2352.53	1050.13	2.24	.052 .
JT: Design Leader	1742.85	1745.79	0.99	.344
JT: Intern	-	-	-	-
Work Hours	453.94	190.59	2.38	.041 *

Note. Y of W=Years of Working, JT=Job Title, SD=Standard Deviation, '.' p<.1, * p<.05, ** p<.01, *** p<.001

Table 13

ANOVA test for the Effects of Depth, Gender, Age, Years of Working, Job Title, and Work Hours on the Number of Steps

	Df	Sum Sq.	Mean Sq.	F-value	P-value
Depth	1	1782313	1782313	3.12	.111
Gender	1	294009	294009	0.51	.491
Age	2	6006172	3003086	5.26	.031 *
Years of Working	3	7505176	2501725	4.38	.037 *
Job Title	5	8554112	1710822	2.99	.072 .
Work Hours	1	3239353	3239353	5.67	.041 *
Residuals	9	5139122	571014		

Note. Y of W=Years of Working, JT=Job Title, Df=Degree of Freedom,
'.' p<.1, * p<.05, ** p<.01, *** p<.001

Table 14 and Table 15 point out the effects of the moderate variables with both distance and depth on the number of steps. Distance (*p*=.037) and work hours (*p*=.018) showed statistical meaning on their slopes of the impact on the number of steps. There were statistically supportive differences between the participants who have worked at the corporation up to 2 years and 11 to 20 years, and between the project managers and interior designers or people who are in the marketing positions (see Table 14).

Considering both distance and depth simultaneously for a linear mixed effect model, ANOVA test was conducted to find out whether each category has different impact on the number of steps. Table 15 summarizes the findings. In terms of the effect on the number of steps, not only distance (*p*=.025) but also depth (*p*=.001) had statistical significance. Work hours also had significantly supportive statistic value on the difference for the number of steps (*p*=.018). Besides those findings, the heterogeneous groups of age (*p*=.028) and years of working (*p*=.015) at the corporation differed in the number of steps. However, based on the findings from the linear mixed effect model and the ANOVA test, different gender and job title did not differ in steps with statistical significance.

Table 14

A Linear Mixed Effect Model for the Effects of Distance, Depth, Gender, Age, Years of Working, Job Title, and Work Hours on the Number of Steps

	Estimate	SD. Error	t-value	P-value
Intercept	-3089.40	2272.00	-1.36	.211
Distance	5.61	2.25	2.50	.037 *
Depth	-24.744	43.30	-0.57	.583
Gender: Female	-355.93	430.17	-0.83	.432
Age: 26-35 yr	437.503	1229.67	0.34	.713
Age: 36-45 yr	-102.01	928.49	-0.11	.915
Y of W.: 2-5 yr	-166.83	1001.12	-0.17	.872
Y of W: 6-10 yr	-1118.66	850.77	-1.31	.225
Y of W: 11-20 yr	-1212.47	612.01	-1.95	.087 .
JT: Project Architect	554.49	559.26	0.99	.350
JT: Interior Designer	1686.63	790.33	2.13	.065 .
JT: Design Researcher	1622.42	1087.69	1.49	.174
JT: Marketing	1858.41	858.13	2.16	.062 .
JT: Design Leader	1825.93	1388.55	1.31	.225
JT: Intern	-	-	-	-
Work Hours	447.26	151.57	2.95	.018 *

Note. Y of W=Years of Working, JT=Job Title, SD=Standard Deviation, '.' p<.1, * p<.05, ** p<.01, *** p<.001

Table 15

ANOVA test for the Effects of Distance, Depth, Gender, Age, Years of Working, Job Title, and Work Hours on the Number of Steps

	Df	Sum Sq.	Mean Sq.	F-value	P-value
Distance	1	2723775	2723775	7.54	.025 *
Depth	1	7838849	7838849	21.71	.001 **
Gender	1	223215	223215	0.61	.454
Age	2	4164519	2082260	5.76	.028 *
Years of Working	3	7151810	2383937	6.60	.015 *
Job Title	5	4386033	877207	2.43	.127
Work Hours	1	3143835	3143835	8.71	.018 *
Residuals	8	2888221	361028		

Note. Y of W=Years of Working, JT=Job Title, Df=Degree of Freedom, '.' p<.1, * p<.05, ** p<.01, *** p<.001

Lastly, to have a final equation explaining the overall influence of distance and depth on the number of steps, a linear mixed effect model was developed with in consideration of age, years of working, and work hours as moderate variables. Table 16 summarizes the results. All the three quantitative variables, which are distance (*p*=.017), depth (*p*=.009), and work hours (*p*=.039), had statistically significant relationship with the number of steps. The ANOVA test (see Table 17), developed based on the model in Table 16, proved that all the variables would impact on the number of steps, and the differences within the groups are statistically supported. The appropriate equation for the mixed effect regression is as followings:

Step = 504.80 + 7.07*Distance + (-97.29)*Depth + 947.29*Age: 26-35 yr
+ 713.91*Age: 36-45 yr + 615.83*Y of W: 2-5 yr + (-712.83)*Y of W: 6-10 yr
+ (-715.78)*Y of W: 11-20 yr + 355.82*Work Hours

Note. Y of W=Years of Working

Table 16

A Linear Mixed Effect Model for the Effects of Distance, Depth, Age, Years of Working, and Work Hours on the Number of Steps

	Estimate	**SD. Error**	**t-value**	**P-value**
Intercept	504.80	1669.82	0.30	.767
Distance	6.07	2.24	2.71	.017 *
Depth	-97.29	32.60	-2.98	.009 **
Age: 26-35 yr	947.29	1145.79	0.83	.422
Age: 36-45 yr	713.91	1005.60	0.71	.489
Y of W.: 2-5 yr	615.83	918.12	0.67	.513
Y of W: 6-10 yr	-712.83	769.00	-0.93	.369
Y of W: 11-20 yr	-715.78	669.42	-1.07	.303
Work Hours	355.82	156.87	2.27	.039 *

Note. Y of W=Years of Working, JT=Job Title, SD=Standard Deviation, ‘.’ p<.1, * p<.05, ** p<.01, *** p<.001

Table 17

ANOVA test for the Effects of Distance, Depth, Age, Years of Working, and Work Hours on the Number of Steps

	Df	Sum Sq.	Mean Sq.	F-value	P-value
Distance	1	2723775	2723775	4.92	.043 *
Depth	1	7838849	7838849	14.17	.002 **
Age	2	4289588	2144794	3.88	.045 *
Years of Working	3	7079978	2539993	4.27	.024 *
Work Hours	1	2845248	2845248	5.14	.039 *
Residuals	14	7742820	553059		

Note. Y of W=Years of Working, JT=Job Title, Df=Degree of Freedom, '.' p<.1, * p<.05, ** p<.01, *** p<.001

Steps and Interactions

In Chapter 2, hypothesis 2 stated that the number of steps might play a role of a mediate variable between distance and depth and the number of interactions. Hence, results derived from several linear mixed effect models and ANOVA tests will be discussed in this section. The variable of work hours was applied to the majority of the models and the tests for analyzing the possible impacts on the number of interactions. Considering work hours was appropriate for the models and the tests because both the number of steps and interactions were highly correlated with work hours.

To begin with, the effects of distance, depth, and the number of steps on the number of interactions were analyzed (see Table 18). Four different regression models were defined to examine each individual variable's effect. Like the result about the relationships among distance, depth, and the number of steps discussed in the previous section (see Table 8), distance (p=.029) and depth (p=.084) had statistically supportive effects on the number of interactions, when they are considered simultaneously. When they were applied independently, their relationships with the number of interactions did not have statistical significance. In addition, Table 18 describes that the correlation between the number of steps and interactions was highly supported with significance (*p*=.000). The degree of the slopes for steps was fairly small, because the number of interactions was generally much smaller compared to the number of steps. The equations for the valid mixed effect regression models to explain the relationships with the number of interactions would be as followings:

Interaction = 9.993 + 0.05*Distance + (-0.432)*Depth

Interactions = 6.619 + 0.003*Steps

Table 18

Four Linear Mixed Effect Models for the Each Effect of Distance, Depth, Distance and Depth, and the Number of Steps on the Number of Interactions

	Estimate	SD. Error	t-value	P-value
Intercept	0.225	8.610	0.02	.979
Distance	0.026	0.018	1.49	.150
Intercept	15.832	10.201	1.55	.132
Depth	-0.060	0.203	-0.29	.770
Intercept	9.993	9.682	1.03	.312
Distance	0.050	0.021	2.38	.029 *
Depth	-0.432	0.238	-1.82	.084 .
Intercept	6.619	2.059	3.21	.003 **
Steps	0.003	0.001	4.92	.000 ***

Note. SD=Standard Deviation, '.' p<.1, * p<.05, ** p<.01, *** p<.001

The data was further analyzed to discover the expansive effect of steps on interactions, as an impact of the mediate variable. Table 19 summarizes the findings from three different linear mixed effect models. They are the regression models regarding the effects of the number of steps, work hours with both distance and depth, or either distance or depth. All the three results showed that distance or depth solely or distance and depth altogether did not have any statistical significance to predict the relationships with the number of steps. On the other hand, the number of steps and the amount of work hours were considered as highly statistically significant variables to predict the relationships on the steps, based on the findings from the three different models. The results demonstrate that the number of steps and the amount of work hours had some positive influence on the number of interactions with statistical significance in all the three models.

Table 19

Three Linear Mixed Effect Models for the Each Effect of Distance and/or Depth, the Number of Steps, and Work Hours on the Number of Interactions

	Estimate	**SD. Error**	**t-value**	**P-value**
Intercept	-5.557	8.917	-0.62	.538
Distance	0.017	0.018	0.93	.360
Step	0.003	0.001	3.62	.000 ***
Work Hours	0.723	0.314	2.30	.023 *
Intercept	5.067	10.41	0.49	.629
Depth	-0.056	20.44	-0.27	.786
Step	0.003	0.001	3.70	.000 ***
Work Hours	0.745	0.313	2.38	.020 *
Intercept	0.821	10.46	0.08	.937
Distance	0.036	0.024	1.47	.162
Depth	-0.307	0.264	-1.16	.259
Step	0.002	0.001	3.53	.000 ***
Work Hours	0.726	0.314	2.31	.022 *

Note. SD=Standard Deviation, '.' p<.1, * p<.05, ** p<.01, *** p<.001

Although distance and/or depth had non-significant statistic value for the correlations in the three regression models, the absence of consideration of other moderate variables might lead that to happen. Therefore, another five different mixed effect models with the moderate variables were explored to understand potential relationships among distance, depth, and steps on interactions. The moderate variables applied to the five models are gender, age, years of working at the corporation, job title, and work hours. Following tables (see from Table 20 to Table 29) describe the findings from the five regression models.

For a start, the effects of distance and the moderate variables were examined. According to the first model, there were statistically significant value on work hours' impact and few differences between subgroups under age, years of working, and job title (see Table 20). ANOVA test (see Table 21), conducted based on the first model, showed that heterogeneous age groups (p=.009) and work hours (p=.000) have significant level for the differences in the number of steps. The result also indicated that the number of interactions differ with moderately supportive statistical value among the subgroups of years of working (p=.086) and job title (p=.086). However, the relationships of distance itself and gender were not statistically significant.

Table 20

A Linear Mixed Effect Model for the Effects of Distance, Gender, Age, Years of Working, Job Title, and Work Hours on the Number of Interactions

	Estimate	SD. Error	t-value	P-value
Intercept	-13.194	15.319	-0.86	.407
Distance	0.030	0.024	1.26	.234
Gender: Female	5.143	3.393	1.51	.179
Age: 26-35 yr	23.816	7.911	3.01	.024 *
Age: 36-45 yr	3.016	5.944	0.51	.628
Y of W.: 2-5 yr	-22.011	7.201	-3.06	.027 *
Y of W: 6-10 yr	-13.726	5.584	-2.46	.057 .
Y of W: 11-20 yr	0.431	3.810	0.11	.914
JT: Project Architect	-9.177	3.747	-2.45	.047 *
JT: Interior Designer	-3.120	5.723	-0.54	.600
JT: Design Researcher	18.751	7.049	2.66	.033 *
JT: Marketing	-9.584	6.253	-1.53	.170
JT: Design Leader	-19.643	9.805	-2.00	.087 .
JT: Intern	-	-	-	-
Work Hours	1.192	0.310	3.84	.000 ***

Note. Y of W=Years of Working, JT=Job Title, SD=Standard Deviation, ‘.’ p<.1, * p<.05, ** p<.01, *** p<.001

Table 21

ANOVA test for the Effects of Distance, Gender, Age, Years of Working, Job Title, and Work Hours on the Number of Interactions

	Df	Sum Sq.	Mean Sq.	F-value	P-value
Distance	1	54.07	54.07	1.583	.234
Gender	1	78.48	78.48	2.297	.179
Age	2	561.79	561.79	16.450	.009 **
Years of Working	3	385.44	128.48	3.761	.086 .
Job Title	5	561.94	112.39	3.290	.085 .
Work Hours	1	504.05	504.05	14.756	.000 ***

Note. Y of W=Years of Working, JT=Job Title, Df=Degree of Freedom, ‘.’ p<.1, * p<.05, ** p<.01, *** p<.001

Subsequently, the variable of the number of steps was added to the previous model in Table 22 and Table 23 to see how the relationships between the variables and the number of interactions differ. As reported by Table 22, both the number of steps and the amount of work hours would influence the number of interactions with statistically significant meaning (p=.000). The subcategories, showing the significant differences in interactions, were pretty similar to the previous model, but the subgroup of marketing got a high significant level and design leader got a more significant one. In terms of ANOVA test for this model, all the variables except distance had statistically significant relationships with the number of interactions. The variables of age and work hours got a slightly higher level of significance, and the variable of gender showed its influence on interaction with marginal significance which was not shown in the previous model (see Table 23).

Table 22

A Linear Mixed Effect Model for the Effects of Distance, Step, Gender, Age, Years of Working, Job Title, and Work Hours on the Number of Interactions

	Estimate	SD. Error	t-value	P-value
Intercept	-1.268	16.10	-0.08	.938
Distance	0.003	0.025	0.12	.906
Step	0.003	0.001	3.92	.000 ***
Gender: Female	7.301	3.716	1.96	.098 .
Age: 26-35 yr	21.67	8.622	2.51	.050 *
Age: 36-45 yr	2.407	6.400	0.37	.719
Y of W.: 2-5 yr	-20.07	7.922	-2.53	.053 .
Y of W: 6-10 yr	-10.07	6.214	-1.62	.167
Y of W: 11-20 yr	4.844	4.316	1.12	.307
JT: Project Architect	-13.23	4.157	-3.18	.017 *
JT: Interior Designer	-10.76	6.331	-1.70	.122
JT: Design Researcher	14.76	7.640	1.96	.096 .
JT: Marketing	-18.02	7.045	-2.56	.037 *
JT: Design Leader	-28.66	10.79	-2.66	.034 *
JT: Intern	-	-	-	-
Work Hours	0.712	0.316	2.25	.026 *

Note. Y of W=Years of Working, JT=Job Title, SD=Standard Deviation, '.' $p<.1$, * $p<.05$, ** $p<.01$, *** $p<.001$

Table 23

ANOVA test for the Effects of Distance, Gender, Age, Years of Working, Job Title, and Work Hours on the Number of Interactions

	Df	Sum Sq.	Mean Sq.	F-value	P-value
Distance	1	0.43	0.43	0.01	.906
Step	1	459.41	459.41	15.41	.000 ***
Gender	1	115.05	115.05	3.86	.098 .
Age	2	345.69	345.69	11.60	.020 *
Years of Working	3	354.89	118.30	3.97	.080 .
Job Title	5	494.60	98.92	3.32	.089 .
Work Hours	1	151.52	151.52	5.08	.026 *

Note. Y of W=Years of Working, JT=Job Title, Df=Degree of Freedom,
'.' p<.1, * p<.05, ** p<.01, *** p<.001

Second, the effects of depth, gender, age, years of working at the corporation, job title, and work hours on the number of interactions were explored. With a consideration of depth in a linear mixed effect model, a few subcategories had a distinct relationship with interactions compared to the each standard subcategory, such as the subcategory of the years of working for 2-5 years compared to the one of the years of working for up to 2 years (see Table 24). Based on the findings from the ANOVA test (see Table 25), the number of interactions were varied in the different age groups (*p*=.011) and work hours (*p*=.000). The number of interactions also was affected moderately by the years of working at the corporation (*p*=.075).

Table 24

A Linear Mixed Effect Model for the Effects of Depth, Gender, Age, Years of Working, Job Title, and Work Hours on the Number of Interactions

	Estimate	SD. Error	t-value	P-value
Intercept	1.84	12.69	0.14	.885
Depth	0.07	0.26	0.28	.778
Gender: Female	6.69	0.31	1.88	.108
Age: 26-35 yr	20.28	3.56	2.32	.056 .
Age: 36-45 yr	-1.17	8.73	-0.19	.855
Y of W.: 2-5 yr	-23.50	6.22	-2.86	.029 *
Y of W: 6-10 yr	-13.04	8.21	-2.04	.090 .
Y of W: 11-20 yr	0.84	6.40	0.18	.860
JT: Project Architect	-11.27	4.60	-2.95	.024 *
JT: Interior Designer	-7.37	3.81	-1.30	.219
JT: Design Researcher	15.73	5.64	2.10	.074 .
JT: Marketing	-12.26	7.48	-1.83	.109
JT: Design Leader	15.72	6.68	-2.25	.054 .
JT: Intern	-	-	-	-
Work Hours	1.20	10.86	3.86	.000 ***

Note. Y of W=Years of Working, JT=Job Title, SD=Standard Deviation, '.' p<.1, * p<.05, ** p<.01, *** p<.001

Table 25

ANOVA test for the Effects of Depth, Gender, Age, Years of Working, Job Title, and Work Hours on the Number of Interactions

	Df	Sum Sq.	Mean Sq.	F-value	P-value
Depth	1	2.77	2.77	0.08	.778
Gender	1	120.47	120.47	3.53	.108
Age	1	458.54	458.54	13.44	.011 *
Years of Working	2	391.05	130.35	3.82	.075 .
Job Title	3	441.90	88.38	2.59	.122
Work Hours	5	509.09	509.09	14.93	.000 ***

Note. Y of W=Years of Working, JT=Job Title, Df=Degree of Freedom, '.' p<.1, * p<.05, ** p<.01, *** p<.001

The model was further expanded to see the effect of the steps on the interactions by adding the variable of steps to the previous model. The model itself was strengthened by having more variables, showing statistically significant value on correlations, with a consideration of steps. Compared to the previous model, more subcategories differed from the each standard subcategory, and the differences were statistically meaningful (see Table 26). In addition, the ANOVA test proved that each moderate variable had different influence on the number of interactions with significantly supportive statistic value. Statistical significant differences existed among the participants who are in the heterogonous groups of gender (p=.079), age (p=.019), years of working (p=.060), and job title (p=.075), and are working for different work hours (p=.026) (see Table 27). Like the previous model exploring the combined effects of distance, steps, and moderate variables on interactions (see Table 22 and Table 23), the number of steps' relationships with interactions was greatly supported with statistical value (p=.000), while depth's correlation with interactions does not have significant one.

Table 26

A Linear Mixed Effect Model for the Effects of Depth, Gender, Age, Years of Working, Job Title, and Work Hours on the Number of Interactions

	Estimate	**SD. Error**	**t-value**	**P-value**
Intercept	3.45	12.15	0.28	.780
Depth	-0.07	0.25	-0.26	.795
Step	0.003	.0007	4.07	.000 ***
Gender: Female	7.48	3.49	2.14	.079 .
Age: 26-35 yr	21.79	8.56	2.55	.045 *
Age: 36-45 yr	2.59	6.14	0.42	.686
Y of W.: 2-5 yr	-19.87	8.10	-2.45	.054 .
Y of W: 6-10 yr	-9.70	6.34	-1.53	.183
Y of W: 11-20 yr	5.43	4.64	1.17	.282
JT: Project Architect	-13.65	3.78	-3.61	.011 *
JT: Interior Designer	-12.24	5.59	-2.19	.054 .
JT: Design Researcher	14.60	7.32	1.99	.091 .
JT: Marketing	-18.81	6.72	-2.80	.027 *
JT: Design Leader	-30.67	10.68	-2.87	.023 *
JT: Intern	-	-	-	-
Work Hours	0.71	0.31	4.07	.026 *

Note. Y of W=Years of Working, JT=Job Title, SD=Standard Deviation, '.' p<.1, * p<.05, ** p<.01, *** p<.001

Table 27

ANOVA test for the Effects of Depth, Steps, Gender, Age, Years of Working, Job Title, and Work Hours on the Number of Interactions

	Df	Sum Sq.	Mean Sq.	F-value	P-value
Depth	1	2.06	2.06	0.07	.795
Step	1	493.16	493.16	16.59	.000 ***
Gender	1	136.20	136.20	4.58	.079 .
Age	1	329.28	329.28	11.07	.019 *
Years of Working	2	401.45	133.82	4.50	.060 .
Job Title	3	512.26	102.45	3.44	.075 .
Work Hours	5	150.89	150.89	5.07	.026 *

Note. Y of W=Years of Working, JT=Job Title, Df=Degree of Freedom, '.' p<.1, * p<.05, ** p<.01, *** p<.001

Lastly, the fifth linear mixed effect model was examined to understand potential relationships among distance, depth, and steps on interactions, having moderate variables as well. All the variables were applied to the fifth regression model. Table 28 describes the results from the linear regression model and Table 29 illustrates the ones from the ANOVA test based on the model. As Table 28 and 29 show, only the number of steps (*p*=.000) and the amount of work hours (*p*=.024) had statistically significant relationships with the number of interactions. In addition, a statistical meaningful difference existed only in the different age group among all the moderate variables (see Table 29).

Table 28

A Linear Mixed Effect Model for the Effects of Distance, Depth, Steps, Gender, Age, Years of Working, Job Title, and Work Hours on the Number of Interactions

	Estimate	SD. Error	t-value	P-value
Intercept	-2.115	17.30	-0.12	.905
Distance	0.024	0.048	0.51	.633
Depth	-0.284	0.488	-0.59	.573
Step	0.003	0.001	3.86	.000 ***
Gender: Female	6.133	4.532	1.35	.239
Age: 26-35 yr	25.65	11.71	2.19	.085 .
Age: 36-45 yr	7.158	10.88	0.66	.542
Y of W.: 2-5 yr	-17.93	9.298	-1.93	.123
Y of W: 6-10 yr	-9.760	6.730	-1.45	.217
Y of W: 11-20 yr	6.022	4.981	1.21	.280
JT: Project Architect	-12.33	4.823	-2.56	.052 .
JT: Interior Designer	-10.67	6.756	-1.58	.157
JT: Design Researcher	16.95	9.023	1.88	.121
JT: Marketing	-17.39	7.691	-2.26	.067 .
JT: Design Leader	-29.52	11.56	-2.55	.044 *
JT: Intern	-	-	-	-
Work Hours	0.722	0.316	2.28	.024 *

Note. Y of W=Years of Working, JT=Job Title, SD=Standard Deviation, '.' p<.1, * p<.05, ** p<.01, *** p<.001

Table 29

ANOVA test for the Effects of Distance, Depth, Steps, Gender, Age, Years of Working, Job Title, and Work Hours on the Number of Interactions

	Df	Sum Sq.	Mean Sq.	F-value	P-value
Distance	1	7.76	7.76	0.26	.633
Depth	1	10.54	10.54	0.35	.573
Step	1	443.82	443.82	14.91	.000 ***
Gender	1	54.51	54.51	1.83	.239
Age	2	259.47	259.47	8.71	.041 *
Years of Working	3	287.88	95.96	3.22	.130
Job Title	5	424.30	84.86	2.85	.135
Work Hours	1	154.92	154.92	5.20	.024 *

Note. Y of W=Years of Working, JT=Job Title, Df=Degree of Freedom, '.' p<.1, * p<.05, ** p<.01, *** p<.001

Interactions and Satisfaction

As the hypothesis 3 stated in Chapter 2 that the number of interactions might eventually affect to job satisfaction, the relationship between these variables were analyzed through correlations. Since job satisfaction is not affected on a daily basis, the data coded by the average number of interactions during the data collection and the average score of job satisfaction were used. Table 6 described the average number of interaction in self-report results section, and Table 5 summarized the average of the responses about job satisfaction in survey results section. Based on those results, all the correlations between two variables were analyzed (see Table 30).

Unlike the assumption of hypothesis 3, there was surprisingly no significant correlation among each question regarding job satisfaction and the number of interactions. Social characteristics of job satisfaction and the number of interactions had negative correlations. These results were unexpected because previous literature describe that having interactions with others and the following social attachment are closely related to the social characteristics (Morgeson & Humphrey, 2006). There might be several reasons for these results. The data used for correlations consists of 18 participant's averaged data during data collection period. With a small quantity of data, it is hard to show a statistically significant correlation and it is unlikely to have statistical significance, which is represented as a low p-value. In addition, the ranges of the number of interactions and the scores of job satisfaction remarkably differ. While the range of the number of interactions is from 3.44 to 26.67, the range of job satisfaction's score is from 1 to 5. In terms of means, the mean of the number of interaction is 13.15 located in the middle of the range, whereas the means of job satisfaction for each characteristic are 3.407, 4.37, and 3.5, which mean the shapes of the graphs are skewed left, especially social characteristics' graph. Since the overall job satisfaction was similar among the participants unlike the number of interaction varied from person to person, meaningful correlations between interactions and satisfaction were not able to be found in this research. In other words, interactions and satisfactions might not be correlated, according to the finding.

Table 30

Correlations among the Number of Interactions and Three Characteristics from Job Satisfaction

Motivational Characteristics of Job Satisfaction	**Correlation (P-value)**	**Ave. Correlation (P-value)**
I receive a great deal of information from my manager and co-workers about my job performance	-0.04 (.885)	
Other people in the organization, such as managers and co-workers, provide information about effectiveness (e.g., quality and quantity) of my job performance.	0.01 (.977)	0.03 (.907)
I receive feedback on my performance from other people in my organization (such as my manager or co-workers).	0.11 (.655)	
Social Characteristics of Job Satisfaction	**Correlation (P-value)**	**Ave. Correlation (P-value)**
The job requires me to monitor a great deal of information.	-0.37 (.132)	
The job requires unique ideas or solutions to problems.	-0.33 (.178)	
The job requires me to utilize a variety of different skills in order to complete the work.	-0.23 (.352)	-0.41 (.090)
The job requires me the performance of a wide range of tasks.	-0.38 (.123)	
The job requires very specialized knowledge and skills.	-0.26 (.295)	
The job provides me the chance to completely finish the pieces of work I begin.	-0.33 (.185)	
Contextual Characteristics of Job Satisfaction	**Correlation (P-value)**	**Ave. Correlation (P-value)**
The seating arrangements on the job are adequate (e.g., ample opportunities to sit, comfortable chairs, good postural support).	0.13 (.600)	-0.12 (.635)
The workplace allows for all different size for people in terms of clearance, reach, eye height, leg room, etc.	-0.29 (.241)	

Note. Values in parentheses are p-values.

Mediate Variable

In the previous section, steps and interactions, five different linear mixed effect models and subsequent ANOVA tests were explored to understand whether or not the effect of steps on interactions exists (see from Table 20 to Table 29). If there is an effect of the mediate variable on the relationships between independent and dependent variables, the slopes of those variables would differ in between before/after the mediate variable intervene in that relationships. In this case, if the after slopes of distance, depth, and the number of interactions were able to show the differences compared with the ones before the number of steps was considered in the model, then those steps would act as a mediate variable.

However, none of the above five linear mixed effect models was applicable to declare the relationships among distance, depth, steps, interactions and moderate variables. The results implied that the number of steps did not play a role as a mediate variable on the relationship between distance and/or depth and the number of interaction. Therefore, the linear mixed effect model was finally analyzed, having the number of steps and the moderate variables (see Table 31). Based on the results, only two subcategories from the variable of years of working at the corporation were not statistically supported the differences with the subgroup of years of working for up to 2 years. However, as described earlier, this does not mean that the whole variable is non-significantly different. It can be interpreted as the differences between the specific subgroup and its standard subgroup. According to Table 31, the rest of them had differences in the number of interactions compared with the each standard subcategory. Furthermore, the ANOVA test implied that all the variables were valid to explain the effects on the number of interactions with highly supportive statistic values (see Table 32). The final equation explaining the effects of the number of steps and moderate variables on the number of interactions is as followings:

Interaction = 0.586 + 0.003*Steps + (7.488)*Female+21.38*Age: 26-35 yr
+ 2.053*Age: 36-45 yr + (-20.22)*Y of W: 2-5 yr + (-9.979)*Y of W: 6-10 yr
+ 4.951*Y of W: 11-20 yr + (-13.45)*JT: PA + (-11.34)*JT: ID + 14.67*DR
+ (-18.36)*JT: MT+ (-29.36)*JT: DL + 0.71*Work Hours

Note. Y of W=Years of Working, JT=Job Title, PA=Project Architect, ID=Interior Designer, DR=Design Researcher, MT=Marketing, DL=Design Leader

Table 31

A Linear Mixed Effect Model for the Effects of Steps, Gender, Age, Years of Working, Job Title, and Work Hours on the Number of Interactions

	Estimate	SD. Error	t-value	P-value
Intercept	0.586	4.943	0.12	.907
Step	0.003	0.001	4.09	.000 ***
Gender: Female	7.488	3.299	2.27	.061 .
Age: 26-35 yr	21.38	7.923	2.30	.034 *
Age: 36-45 yr	2.053	5.484	0.37	.719
Y of W.: 2-5 yr	-20.22	7.561	-2.67	.037 *
Y of W: 6-10 yr	-9.979	5.905	-1.69	.143
Y of W: 11-20 yr	4.951	4.050	1.22	.263
JT: Project Architect	-13.45	3.509	-3.83	.007 **
JT: Interior Designer	-11.34	4.119	-2.75	.029 *
JT: Design Researcher	14.67	6.925	2.12	.071 .
JT: Marketing	-18.36	6.182	-2.97	.019 *
JT: Design Leader	-29.36	8.857	-3.31	.014 *
JT: Intern	-	-	-	-
Work Hours	0.710	0.315	2.25	.026 *

Note. Y of W=Years of Working, JT=Job Title, SD=Standard Deviation, '.' p<.1, * p<.05, ** p<.01, *** p<.001

Table 32

ANOVA test for the Effects of Steps, Gender, Age, Years of Working, Job Title, and Work Hours on the Number of Interactions

	Df	Sum Sq.	Mean Sq.	F-value	P-value
Step	1	495.67	495.67	16.72	.000 ***
Gender	1	152.76	152.76	5.15	.061 .
Age	1	376.39	376.39	12.69	.012 *
Years of Working	2	452.68	150.89	5.09	.042 *
Job Title	3	588.63	117.73	3.97	.053 .
Work Hours	5	150.88	150.88	5.08	.026 *

Note. Y of W=Years of Working, JT=Job Title, Df=Degree of Freedom,
'.' $p<.1$, * $p<.05$, ** $p<.01$, *** $p<.001$

Moderate Variables

In this section, the effects of the variables, considered as the moderate variables, on the number of steps and interactions will be analyzed. As discussed in Chapter 2, the social ecological model describes that the personal, organizational, and environmental factors can tremendously affect people's behavior directly and/or indirectly. From this perspective, this research asked a question about those factors on the number of steps, as a result of people's behavior, and the third research question was finally developed. Gender, age, the number of years of working at the corporation, job title, work hours, habitual walking behavior, and difficulty in walking were considered as moderate variables in this research. For personal factors, demographic information including gender and age, years of working, habitual walking behavior, and difficulty in walking were analyzed. Job title and work hours were analyzed for organizational factors. Lastly, the research was originally designed to discover the effects of the moderate variables on the number of steps, but the analyses about the effects were expanded to the number of interactions as well. Since the findings from this research showed the great influence of the participant's individual differences on the correlation about the number of steps and interactions (see *Figure 10* and *Figure 11*), the effects of moderate variables on the number of interactions were further examined.

Gender between Steps and Interactions. First, the effect of gender on the number of steps and interaction was analyzed through t-tests (see Table 33). From the results, the high p-values indicated the differences between genders do not exist in the both number of the steps and interactions.

Table 33

T-tests for the Effect of Gender on the Each Number of Steps and Interactions

	Df	t-value	P-value	Mean	
				Male	Female
Step	9.50	-0.409	.692	1704.25	1909.21
Interaction	8.38	0.056	.955	13.29	13.08

Note. Df=Degree of Freedom, '.' p<.1, * p<.05, ** p<.01, *** p<.001

Steps.

Age, years of working, and job title on the number of steps. Three ANOVA tests were conducted to understand the existing effects of different groups of age, years of workings, and job titles on the number of steps (see Table 34). The variable of age showed that the number of steps would differ between age groups with statistical significant (*p*=.039) with two in degree of freedom and 4.04 in F-value. Steps also differed between years of working with marginally significance (*p*=.090) with three in degree of freedom and 2.64 in F-value. With one in degree of freedom and 4.57 in F-value, the fact that different job titles would correlate with the different number of steps had statistical supportive significance for moderating variables (*p*=.048).

Table 34

ANOVA tests for the Effects among Different Groups of Age, Years of Working, and Job Title on the Number of Steps

	Df	Sum Sq.	Mean Sq.	F-value	P-value
Age	2	5540530	2720265	4.04	.039 *
Residuals	15	10107914	673861		
Years of Working	3	5615304	1871768	2.64	.090 .
Residuals	14	9933140	709510		
Job Title	1	3453627	3453627	4.57	.048 *
Residuals	16	12094816	755926		

Note. Df=Degree of Freedom, '.' p<.1, * p<.05, ** p<.01, *** p<.001

Figure 13, consisting of three graphs, shows the difference among each subcategory with the bolded line, indicating a mean value, within the same variable. The following three tables (from Table 35) summarize the degree of differences between each subcategory within the same variable.

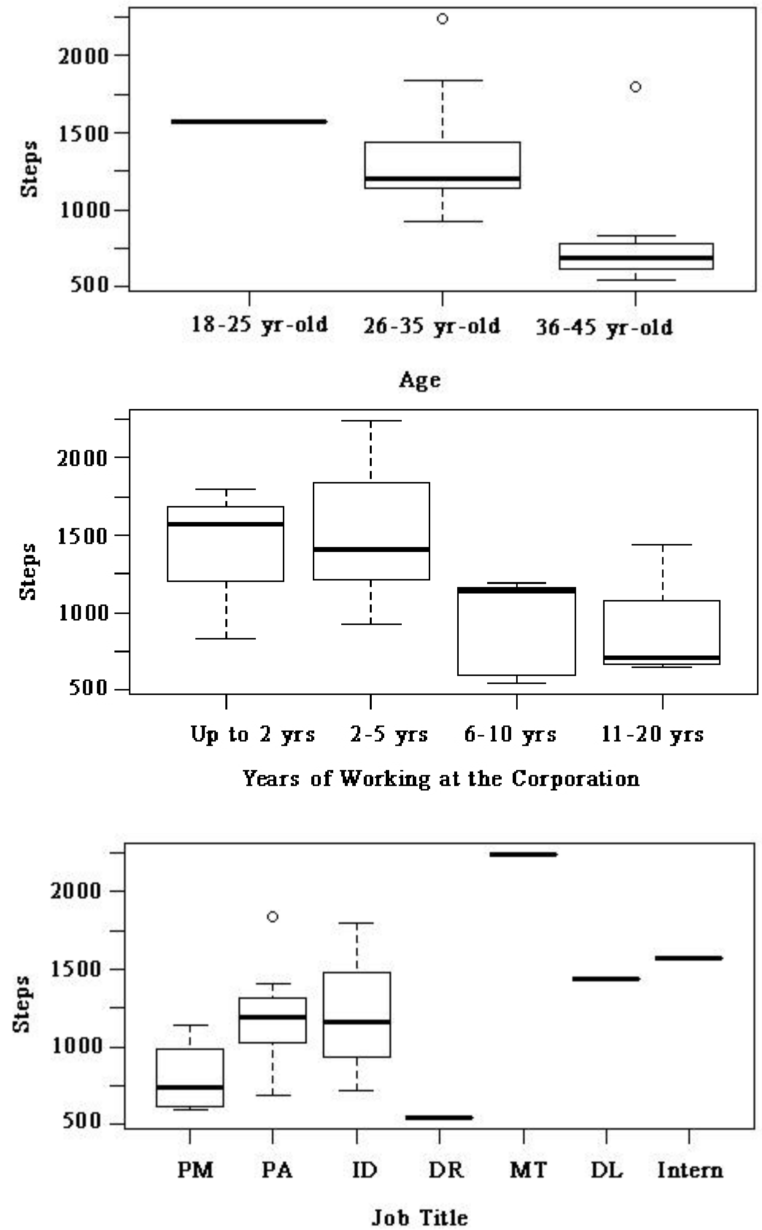


Figure 13. Box plots for the average number and ranges of steps according to the each subcategory in the groups of age, years of working, and job title

Note. PA=Project Architect, ID=Interior Designer, DR=Design Researcher, MT=Marketing, DL=Design Leader,

Table 35

ANOVA tests for the Differences Between Each Different Group of Age, Years of Working, and Job Title on the Number of Steps

Age	Mean Difference	SD. Error	P adj.	95% Confidence Level	
				Lower	Upper
26-35 yr *vs* 18-25 yr	-409.11	820.89	.884	-2545.42	1827.20
36-45 yr *vs* 18-25 yr	-1483.78	820.89	.241 *	-3763.24	795.68
36-45 yr *vs* 26-35 ys	-1074.67	820.89	.045 *	-2125.45	-23.89
Years of Working	**Mean Difference**	**SD. Error**	**P adj.**	**95% Confidence Level**	
				Lower	**Upper**
2-5 yr *vs* Up to 2 yr	248.17	842.32	.976	-1439.79	2036.14
6-10 yr *vs* Up to 2 yr	-880.98	842.32	.475 *	-2612.17	850.21
11-20 yr *vs* Up to 2yr	-1053.64	842.32	.390 *	-2923.53	816.26
6-10 yr *vs* 2-5 yr	-1129.15	842.32	.167 *	-2611.66	353.35
11-20 yr *vs* 2-5 yr	-1301.81	842.32	.144 *	-2944.16	340.54
11-20 yr *vs* 6-10 ys	-172.66	842.32	.988	-1753.01	1407.69
Job Title	**Mean Difference**	**SD. Error**	**P adj.**	**95% Confidence Level**	
				Lower	**Upper**
PA *vs* PM	794.51	752.94	.639	-883.39	2472.42
ID *vs* PM	842.19	752.94	.759	-1202.42	2886.79
DR *vs* PM	-517.16	752.94	.995	-3510.16	2475.83
Marketing *vs* PM	2875.33	752.94	.023 *	-117.66	5868.33
DL *vs* PM	1276.56	752.94	.731	-1716.44	4269.55
Intern *vs* PM	1541.20	752.94	.556	-1451.79	4534.20
ID *vs* PA	47.67	752.94	.999	-1799.64	1894.99
DR *vs* PA	-1311.68	752.94	.669	-4173.53	1550.17
Marketing *vs* PA	2080.82	752.94	.219 *	-781.81	4942.67
DL *vs* PA	482.04	752.94	.995	-2379.81	3343.89
Intern *vs* PA	746.69	752.94	.960	-2115.16	3608.54
DR *vs* ID	-1359.35	752.94	.706	-4450.40	1731.80
Marketing *vs* ID	2033.15	752.94	.306 *	-1058.00	5124.30
DL *vs* ID	434.37	752.94	.998	-2656.78	3525.52
Intern *vs* ID	699.50	752.94	.979	-2392.14	3790.17
Marketing *vs* DR	3392.50	752.94	.089 *	-393.37	7178.37
DL *vs* DR	1793.72	752.94	.638	-1992.15	5579.60
Intern *vs* DR	2058.37	752.94	.499 *	-1727.51	5844.24
DL *vs* Marketing	-1598.78	752.94	.739	-5384.65	2187.10
Intern *vs* Marketing	-1334.13	752.94	.859	-5120.01	2451.74
Intern *vs* DL	264.65	752.94	.999	-3521.23	4050.52

Note. PA=Project Architect, ID=Interior Designer, DR=Design Researcher, MT=Marketing, DL=Design Leader, SD=Standard Deviation, * P adj. <.5, In the ANOVA test, an adjusted p-value indicates the differences between two different categories. If an adjusted p-value is closer to 1, it means the results do not differ in the two different groups. Conversely, an adjusted p-value closer to 0 indicates difference in the categories. Referring to the findings in Table 35, the number of steps differed in between 36-45 years and 18-25 years and between 36-45 years and 26-35 years within the age group. Within the years of the working group, the number of steps was different in all the subcategories, excluding between up to 2 years and 2-5 years and between 6-10 years and 11-20 years. Within the job title group, differences existed between the marketing position and project management, project architect, and interior design, and between the intern and design researcher.

Work hours on the number of steps. As one of the organizational factors, the effect of work hours on the number of steps was explored. Work hours and the number of steps were highly correlated with statistical significance (see Table 7 and Table 8). Strong positive correlations were found both in the data using the variables' averages (p=.009) and in the data coded by day (p=.000) (see Table 36). The regression model was also valid to examine the relationship between two variables. The equation for this model is as followings:

$$\text{Steps} = 158.06 + 163.79 * \text{Work Hours}$$

Table 36

A Regression for the Effect of Work Hours on the Number of Steps

	Estimate	**SD. Error**	**t-value**	**P-value**
Intercept	158.06	314.19	1.85	.067 .
Work Hours	163.79	34.89	4.69	.000 ***

Note. SD=Standard Deviation, '.' p<.1, * p<.05, ** p<.01, *** p<.001

Habitual walking behavior and difficulty in walking on the number of steps. The potential effects of habitual walking behavior and difficulty in walking on steps were examined through correlations and regressions. There was a statistically significant and positive strong correlation between habitual behavior of walking and the number of steps (*p*=.072). On the other hand, a non-significant correlation was found between difficulty in walking and the number of steps (see Table 37).

Table 37

Correlations between Habitual Walking Behavior, Difficulty in Walking and the Number of Steps

Habitual Walking Behavior	**Correlation (P-value)**	**Ave. Correlation (P-value)**
Physical activity is something I do frequently.	0.45 (.058)	0.43 (.072)
Physical activity is something I do automatically.	0.38 (.124)	
Physical activity is something I do without having to consciously remember.	0.41 (.095)	
Physical activity is something I do without thinking.	0.29 (.250)	
Physical activity is something that belongs to my (daily, weekly, monthly) routine.	0.33 (.182)	
Physical activity is something I start doing before I realize I am doing it.	0.39 (.106)	
Difficulty in Walking	**Correlation (P-value)**	**Ave. Correlation (P-value)**
I have no difficulties in walking.	0.12 (.644)	-

The two variables were further analyzed to explore their additional effects through regressions. Only the habitual walking behavior had a relationship with the number of steps with statistical significance (see Table 38). Interestingly, the effect of the variable on the steps was strengthened when it was considered with difficulty in walking simultaneously, by having higher degree of slope. However, the variable of difficulty in walking itself was unable to prove its effect with statistical significance through the regressions.

Table 38

Three Regressions for the Effects of Habitual Walking Behavior and/or Difficulty in Walking on the Number of Steps

	Estimate	SD. Error	t-value	P-value
Intercept	103.1	925.4	0.11	.913
Habitual Walking Behavior*	496.5	257.5	1.93	.072 .
Intercept	1323.7	1123.8	1.18	.256
Difficulty in Walking	113.5	241.4	0.47	.645
Intercept	634.7	1071.6	0.59	.562
Habitual Walking Behavior*	717.2	314.4	2.10	.053 .
Difficulty in Walking	-286.3	290.2	-0.98	.339

Note. The data with the averages was used for Habitual Walking Behavior*, SD=Standard Deviation, '.' p<.1, * p<.05, ** p<.01, *** p<.001

Overall effects of moderate variables on the number of steps. As a final point, the overall effects of moderate variables on the number of steps will be discussed in this section. Table 39 shows the overall effects on the steps when they were considered altogether at the same time. As Table 39 explains, only the three out of seven variables showed their influences on the number of steps, with statistical significance. The three variables having relationships with the steps are years of working at the corporation (p=.037), job title (p=.053), and work hours (p=.009).

Table 39

A Regression for the Effects of All the Moderate Variables on the Number of Steps

	Estimate	SD. Error	t-value	P-value
Intercept	-2243.48	2049.99	-1.09	.291
Gender	408.57	451.34	0.90	.380
Age	-45.55	434.87	-0.10	.928
Years of Working	-486.72	202.13	-2.42	.037 *
Job Title	287.26	127.50	2.25	.053 .
Work Hours	533.96	179.29	2.98	.009 **
Habitual Walking Behavior*	140.87	360.93	0.39	.703
Difficulty in Walking	-100.23	316.87	-0.31	.756

Note. The data with the averages was used for Habitual Walking Behavior*, SD=Standard Deviation, '.' p<.1, * p<.05, ** p<.01, *** p<.001

Therefore, a final regression was developed to summarize the comprehensive relationships between moderate variables and the number of steps. The variables of age, years of working, job title, and work hours were considered for this model (see Table 40 and Table 41). All of four variables showed their relationships with steps by having statistically significant value. The final equation explaining the effects of the moderate variables on the number of steps is as followings:

Steps = (-1055.2) + (-308.5)*Age: 26-35 yr + (-989.6)*Age: 36-45 yr
+ (-292.78)*Y of W: 2-5 yr + (-1080)*Y of W: 6-10 yr + (-1185.8)*Y of W: 11-20 yr
+ 107*JT: PA + 1008*JT: ID + 1224.7*DR + 1236.4*JT: MT+ 1010.6*JT: DL
+ 0.71*Work Hours

Note. Y of W=Years of Working, JT=Job Title, PA=Project Architect, ID=Interior Designer, DR=Design Researcher, MT=Marketing, DL=Design Leader

Table 40

A Regression for the Effects of Age, Years of Working, Job Title, and Work Hours on the Number of Steps

	Estimate	**SD. Error**	**t-value**	**P-value**
Intercept	-1055.2	1418.5	-0.74	.485
Age: 26-35 yr	-308.5	873.7	-0.35	.763
Age: 36-45 yr	-989.6	596.8	-1.66	.148
Y of W.: 2-5 yr	-292.8	718l8	-0.41	.698
Y of W: 6-10 yr	-1080.0	595.2	-1.81	.119
Y of W: 11-20 yr	-1185.8	438.4	-2.70	.035 *
JT: Project Architect	107.0	415.3	0.26	.805
JT: Interior Designer	1008.0	392.4	2.57	.042 *
JT: Design Researcher	1224.7	813.7	1.53	.177
JT: Marketing	1236.4	736.2	1.70	.144
JT: Design Leader	1010.6	883.5	1.14	.296
JT: Intern	-	-	-	-
Work Hours	493.4	178.9	2.758	.033 *

Note. Y of W=Years of Working, JT=Job Title, SD=Standard Deviation,
'.' p<.1, * p<.05, ** p<.01, *** p<.001

Table 41

ANOVA test for the Effects of Steps, Gender, Age, Years of Working, Job Title, and Work Hours on the Number of Interactions

	Df	Sum Sq.	Mean Sq.	F-value	P-value
Age	2	5440530	2720265	12.80	.006 **
Years of Working	3	3853087	1284362	6.04	.030 *
Job Title	5	3362321	672464	3.16	.096 .
Work Hours	1	1617274	1617274	7.61	.034 *
Residuals	6	1275232	212539		

Note. Y of W=Years of Working, JT=Job Title, Df=Degree of Freedom, '.' p<.1, * p<.05, ** p<.01, *** p<.001

Interactions.

Age, years of working, and job title on the number of steps. Three ANOVA tests were conducted to explore the effects of different groups of age, years of workings, and job titles on the number of interactions (see Table 42). Only the years of working variable showed that the number of steps would differ in different age group, however the relationship is marginally statistical significant (p=.077) with three in degree of freedom and 2.83 in F-value.

Table 42

ANOVA tests for the Effects among Different Groups of Age, Years of Working, and Job Title on the Number of Interactions

	Df	Sum Sq.	Mean Sq.	F-value	P-value
Age	2	10.9	5.45	0.11	.892
Residuals	15	708.6	47.24		
Years of Working	3	271.5	90.5	2.83	.077 .
Residuals	14	448.0	32.0		
Job Title	6	337.2	56.19	1.46	.254
Residuals	16	616.1	38.51		

Note. Df=Degree of Freedom, '.' p<.1, * p<.05, ** p<.01, *** p<.001

Figure 14, consisting of three graphs, shows the differences among each subcategory with the bolded line, indicating a mean value, within the same variable. The following Table 43 summarizes the degree of differences between each subcategory within the years of working variable, since only that variable showed statistical significance. As seen in Table 43, the number of interactions would be likely to differ in between the subgroups of 2-5 years of working and 6-10 and 11-20 years of working.

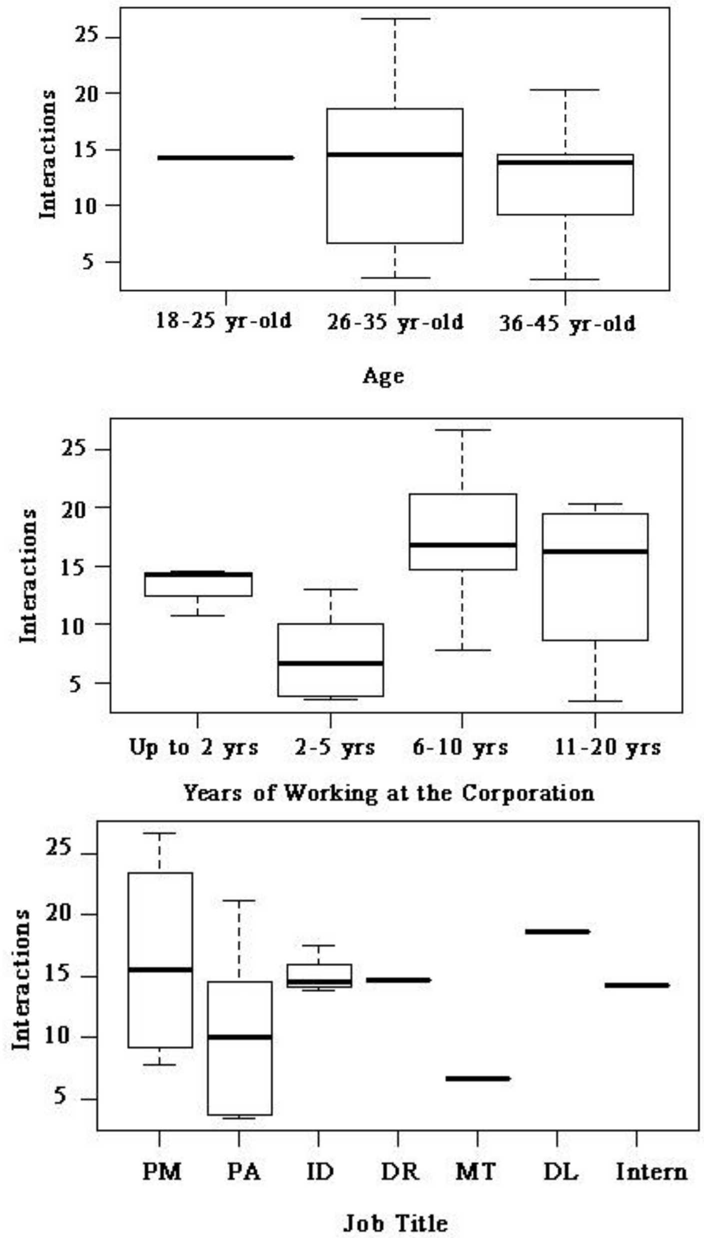


Figure 14. Box plots for the average number and ranges of interactions according to the each subcategory in the groups of age, years of working, and job title

Note. PA=Project Architect, ID=Interior Designer, DR=Design Researcher, MT=Marketing, DL=Design Leader,

Table 43

ANOVA test for the Differences Between Each Different Group of Years of Working on the Number of Steps

	Mean Difference	SD. Error	P adj.	95% Confidence Level	
				Lower	Upper
2-5 yr *vs* Up to 2 yr	-5.75	5.65	.542	-17.76	6.26
6-10 yr *vs* Up to 2 yr	4.14	5.65	.731	-7.48	15.77
11-20 yr *vs* Up to 2yr	0.99	5.65	.997	-11.68	13.44
6-10 yr *vs* 2-5 yr	9.89	5.65	.051 *	-0.01	19.85
11-20 yr *vs* 2-5 yr	6.63	5.65	.337 *	-4.40	17.66
11-20 yr *vs* 2-5 ys	-3.26	5.65	.808	-13.88	7.35

Note. SD=Standard Deviation, * P adj. <.5,

Work hours on the number of interactions. As one of the organizational factors, the variable of work hours was explored to understand its effect on the interactions. Work hours and the number of steps showed a strong positive correlation with highly significant statistical value (p=.002) in the data coded by day (see Table 44). The regression model was also valid to explain the relationship between work hours and the number of interactions. The equation for this model is as followings:

$$\text{Interactions} = 4.028 + 1.188 * \text{Work Hours}$$

Table 44

A Regression for the Effect of Work Hours on the Number of Interactions

	Estimate	SD. Error	t-value	P-value
Intercept	4.028	2.720	1.48	.142
Work Hours	1.188	0.305	3.89	.000 ***

Note. SD=Standard Deviation, ‘.’ p<.1, * p<.05, ** p<.01, *** p<.001

Discussion

The findings from the data analyses will be discussed in this section. Figure 15 illustrates a newly suggested conceptual model explaining the relationships among the independent, dependent and moderate variables based on the findings in this research. As a framework, the findings will be analyzed using the following hypotheses.

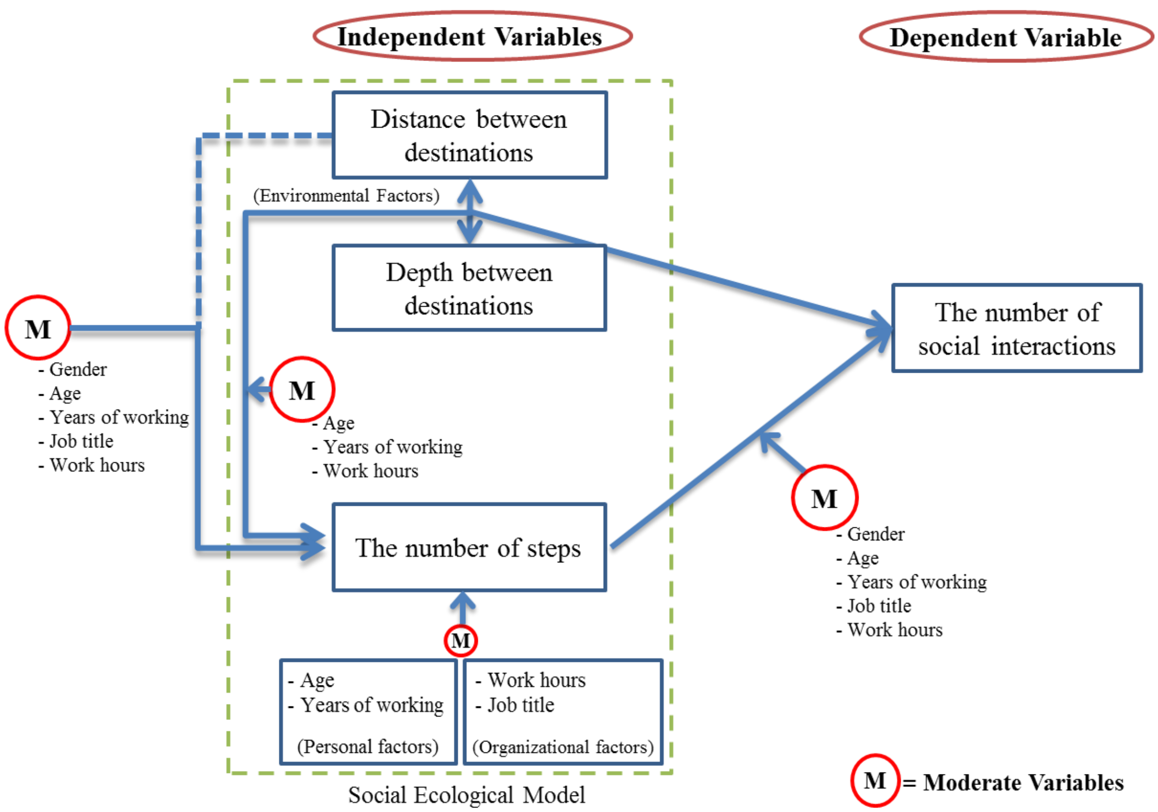


Figure 15. Conceptual model based on the findings

Hypothesis 1: Increased distance and depth between an employee's workstation and other destinations will increase the number of steps he/she walk.

To verify this hypothesis, the overall effects of distance and depth both separately and simultaneously on the number of steps were analyzed through the linear mixed effect models. Distance and depth for each participant are the accumulated distance and depth between his/her own workstation and the 12 frequently visited zones of their destinations. Depth, one of the main constructs defined in space syntax theory, has a statistically significant and strong positive relationship with distance (*p*=.004) (see Table 7). As shown in Table 9, which describes the results of multiple regressions, distance and depth did not have significant effect on the number of steps the participants walked during the data collection period, when they were considered independently. However, if they were considered at the same time to determine the relationship with the steps, they showed significant correlations. To be specific, distance had a positive relationship with the number of steps, while depth had a negative correlation.

These results might imply that the accumulated longer distance to each of the 12 frequently visited zones a participant's workstation has, the more steps he/she might walk during the day in the office. A negative relationship between depth and steps can be interpreted that a workstation in a deeper zone might have an influence on having a lower number of steps. If a participant's workstation is located at the deeper zones relative to a destination on the floor plan, he/she needs to pass through more axial lines to get there. A degree of depth might mean a degree of isolation of the zone. Based on these results, if a participant's workstation has a higher degree of distance and a greater degree of depth at the same time, he/she might decide not to walk to a destination which he/she requires him/her to pass through several zones; instead he/she might try to fulfill his/her need without traversing the zones, if possible. Those psychological thoughts and intentions might lead to a negative relation between depth and the number of steps. Given these points, increased distance and decreased depth between an employee's workstation and other destinations would increase the number of steps they walk during the day at work.

Hypothesis 2: The greater steps as a mediate variable will correlate to the number of face-to-face interactions with others.

To verify this second hypothesis, two different analyses were conducted. The first analysis conducted was discovering the relationships between the number of steps and interactions. Once the correlations were found between them, the second analysis was conducted to discover whether or not the number of steps play a role of a moderate variable for the relationship between distance and depth and the interactions. The results were found by utilizing the linear mixed effect models. From the correlations (see Table 8), there was a moderate positive relationship with a statistical significance (p=.001) between the number of steps and interactions. According to the linear mixed effect model (see Table 18), there is also a positive correlation between these two variables. In terms of a relationship among distance, depth, and the number of interactions, there was a statistically supportive relationship as well, and the result was quite similar to the relationship among distance, depth, and the number of steps. Although there was no relationship to the number of interactions from the separate effects of distance and depth, a correlation was found when distance and depth were analyzed together. Distance and the number of interactions had a positive relationship; on the other hand, depth and the interactions had a negative one (see Table 18).

From these results, the participants who walked a greater number of steps during the day at work might have a tendency to have more face-to-face interactions. The results also imply that if the participant have a greater degree of accumulated distance from the participant's workstation to the 12 frequently visited zones, he/she is likely to have more face-to-face interactions than people who have a lower degree of distance. In addition, if the workstation has a lower degree of depth relative to the zones at the same time, the participant would have more face-to-face interactions. This might happen because the zones with a lower degree of depth have an easier access to other spaces and a higher chance to be exposed to other and more people.

Regarding the effect of the number of steps as a mediate variable, eight different linear mixed effect models were examined. Three of them were examining about the relationships among distance, depth, the number of steps, and the number of interactions. Five of them were developed to find the effects of those variables with simultaneous consideration of mediate variables. None of the eight different models could prove the impact of the number of steps as a mediate variable with a statistically significant value on the number of interactions. Therefore, the number of steps should not be considered as a mediate variable on the relationship between distance and depth, and the number of interactions. However, since the number of steps alone and distance and depth together showed their relationships with the number of interactions, the number of steps should be regarded as one of the independent variables, rather than a mediate variable. To be brief, the greater number of steps would correlate to the number of face-to-face interactions with others, but the number of steps alone would not be a mediate variable on the relationship between distance and depth, and the number of interactions.

Hypothesis 3: The greater number of interactions will correlate to higher job satisfaction.

To demonstrate the third hypothesis, the number of interactions collected through self-reports for 10 business days and the participants' responses to the questions asking about job satisfaction through the questionnaire were analyzed by using correlation.

Between the number of interactions and job satisfaction, most of the correlations had, startlingly, no statistically significant value. Interactions did not have statistically significant relationship with motivational characteristics of job satisfaction (p=.907), and with job satisfaction about contextual characteristics (p=.635) (see Table 30). Even more surprisingly, there was a statistically significant strong negative correlation between interactions and social characteristics of job satisfaction. Social characteristics are the most relevant characteristics to social attachment and engagement through interactions, among three characteristics in the Work Design Questionnaire (WDQ); however, the result from correlation was the opposite.

The difference in the shape and the range of graphs for the two variables can explain the result and suggest its overall implications. The number of interactions has a normal distribution whereas the job satisfaction's three characteristics have skewed left distribution. This means that the majority of the participants had an overall higher job satisfaction, while the number of interactions they had per day could be varied from 3.44 to 26.77. Therefore, the result could imply that no matter how many face-to-face interactions the participants had, they might already be the people who would love and be satisfied with their jobs and their working environment. Otherwise, the number of face-to-face interactions would not affect their job satisfaction because they might already have a higher job satisfaction from other features of Office A. In conclusion, this research found that the greater number of interactions does not correlate with a higher level of job satisfaction.

Hypothesis 4: **Personal, organizational, and environmental factors will play a moderating role between distance and depth, and the number of steps.**

To demonstrate the last hypothesis, at first, the moderate variables were examined to determine whether there were correlations between them and the number of steps. After that, whether or not they had a moderating role among variables was explored. A main function of a moderate variable is either supporting or hindering a relationship between other variables. As the social ecological model is defined, personal, organizational, and environmental factors were developed. For this research, personal factors were gender, age, the number of years of working at Office A, habitual walking behavior, and difficulty in walking; organizational factors were job title and work hours; and environmental factors were distance and depth, which were independent variables as well.

As Table 33 shows, there was no significant difference in the number of steps based on gender. However, according to Figure 13, Table 34 and Table 35, different ages and years of working would influence the number of steps the participants made. The older the participants were and the longer they had worked for the corporation, the less number of steps they were likely to walk. Furthermore, a very strong positive correlation between habitual walking behavior and the number of steps was found, with a statistical significance (p=.072) (see Table 37). That implies people who have a tendency to walk habitually might be apt to walk more during the day at work. However, difficulty in walking and the number of steps had no correlation, since most of the participants had no difficulty in walking. In terms of organizational factors, work hours had not only a very strong positive correlation with the number of steps (see Table 7 and Table 8), but also had a statistically significant value (see Table 44). The number of steps differed in job title, although the majority of the participants were project managers, project architects, or interior designers. In addition, as discussed earlier for the hypothesis 1, distance and depth together had a relationship to the number of steps. To sum up, the number of steps might be affected by different ages, years of working, habitual walking behavior, job title, and work hours.

The overall effects on the number of steps were investigated by considering all the moderate variables together at the same time. When considering the independent variables as environmental factors, distance, depth, age, years of working, and work hours showed relationships to the steps through the linear mixed effect model (see Table 16). Thus, the number of steps, as a function of human's behavior, was affected by distance and depth (as environmental factors), age and years of working (as personal factors), and work hours (as an organizational factor), according to the social ecological model. When the environmental factors, distance and depth, were not considered in the model, age and years of working as personal factors, and work hours and job title as organizational factors would affect the number of interactions. In short, since all three factors influenced the number of steps, this research supports the social ecological model.

In addition, the simultaneous effect of distance and depth on the steps was still supported when considering age, years of working, and work hours. Another interesting finding was that distance itself did not have a strong relationship with the number of steps, according to the linear mixed effect model, considering random effects of participants (see Table 9). However, when the moderate variables (gender, age, years of working, job title, and work hours) were dealt with together, distance became a factor in the number of steps (see Table 10 and Table 11). Therefore, this research also supports the idea that the personal and organizational factors play a moderating role between distance and depth, and the number of steps.

This research further examined the effect of moderate variables on the number of interactions, since interactions can be viewed as human behaviors and can be greatly influenced by the participants' individual differences. Similar to the result of gender's effect on steps, there was no gender difference in the number of interactions (see Table 33). Different ages and job titles did not have significant differences, either. However, work hours had a positive correlation (see Table 8) as well as a significant influence on the interactions (see Table 44). Although some of the moderate variables did not have a relation with the number of interactions when examined alone, there were statistically significant effects as the moderate variables when they were considered together. For the number of interactions, when the moderate variables of gender, age, years of working, job title, and work hours were added with the number of steps to the linear model, the result was still supported. Hence, this result also supports the idea that the personal and organizational factors play a moderating role between the number of steps and interactions.

Major Findings

Based on the data analysis, the major findings related to the hypotheses in this research follow:

1. Increased distance and decreased depth between an employee's workstation and other destinations will increase the number of steps they walk.

2. The greater steps would correlate to the number of face-to-face interactions

with others, but the number of steps alone would not be a mediate variable on the relationship between distance and depth, and the number of interactions.

3. The greater number of face-to-face interactions does not correlate with a higher level of job satisfaction.

4. The personal and organizational factors play a moderating role on the relationships not only between distance and depth, and the number of steps, but also between the number of steps and interactions.

5. The social ecological model is supported since the personal, organizational, and environmental factors in the model had an influence on the number of steps which is an outcome of human behavior.

CHAPTER 5: CONCLUSION

Overview of Conclusion

This research explored how interior layout affects people's movement and face-to-face interactions in the working environment. Personal, organizational, and environmental factors which affect the relationships were also investigated. A conceptual framework for this research was developed on the basis of the space syntax theory and the social ecological model. This chapter will discuss the implications and the limitations by summarizing the findings, and offer recommendations for future research.

Implications

The findings from this research have several implications. Some of the major findings support the results from previous literature. Several studies have shown that being active results in positive outcomes and there are trends nowadays that encourage physical activity in the working environment (Prodaniuk et al., 2004; Wells et al., 2007; Zimring et al., 2005). Throughout a couple of decades, there has been a positive relationship between the structure of space and the pattern of movements (Hillier, 2007; Hillier et al., 1993; Penn et al., 1999; Peponis et al., 2007).

A positive correlation between spatial layouts and interactions in working organization has been also found from previous literature (Penn et al., 1999; Peponis et al., 2007; Rashid et al., 2006). For example, Penn et al. (1999) found that two different interior layouts greatly changed the patterns of employees' interaction and movement. Rashid et al. (2006) also discovered that there is a strong and positive relationship between interactions and co-presence, and the co-presence is hugely affected by the spatial layout. Since this present research also found the positive correlation between distance and depth, and the number of steps and interactions, it was able to build on this body of knowledge. However, few studies have examined a correlation between movement and interaction in working environments. Therefore, the present research not only supports the previous findings, but also fills the gaps from previous studies.

The importance of social support in working environment has been highlighted in previous literature (Berkman et al., 2000; McNeill et al., 2006). McNeill et al. (2006) especially emphasize the significance of high support serving as a buffer against stress and giving relief to employees. The authors also mentioned that people can feel attachment and connectedness to others through a social network, and that would affect their job satisfaction eventually. However, in this research, there was no significant correlation between the number of interactions and job satisfaction, in contrast with previous findings.

Lastly, the results from this research were greatly tied with space syntax theory, as well as the social ecological model. This research implied that depth, which is one of six constructs in space syntax theory and describes the spatial layout' usage, had relationships with the number of steps and interactions. As the theory illustrates, depth and distance (distance is not a construct in space syntax theory) are closely related to each other. Therefore, the relationships were not supportive ones when either distance or depth was considered separately, whereas they became supported when the two concepts were considered together. In terms of the social ecological model, both the number of steps and interactions which were the outcomes of people's behaviors were affected by the personal, organizational, and environmental factors. All three types of factors from the social ecological model played a moderating role on the results of people's movement and communicating behavior. In conclusion, this research provides supportive implications to the both space syntax theory and social ecological model.

Limitations

There are several limitations to this research. The biggest limitation of this research is having a small sample size is another limitation of this research. Of the total 21 participants recruited for this research, only 18 participants' data were examined. When conducting a quantitative method, the sample size commonly matters to the results, especially to make a generalization from the findings (Lock et al., 2013). It would also be hard to examine the differences among the groups when there is a small sample size for each group. For this research, some of the job titles included only one person. In other words, making comparisons between the diverse job titles does not have solid justifications because those differences might be a result of various personal characteristics rather than of the diverse job titles. Therefore, having a small sample size is a limitation.

Another biggest limitation of this research is having low reliability. Because of the fact that this data collection was largely dependent on participants, the reliability of the study might be questionable due to human error. To put it another way, being that the majority of the data were self-reporting, the data might have low reliability. The participants were asked to report the numbers on their pedometers and the interactions they had during the work hours on the self-report from daily. They were also required to put on their pedometers whenever they arrived at work and put them off if they need to leave the office. However, they might forget to report every single interaction they had, or to put a pedometer back on them after coming back from outside meetings. Or, they might report incorrect information such as marking an interaction as a face-to-face interaction when it is not.

Another limitation of this research is the high chance of changing the participants' behavior. Since they knew that they were participating in the research and needed to report some information every day, that fact might simply and easily change their behavior. In addition, by doing self-reports and the questionnaire, they were likely well aware of the main interests in this research. For example, they might walk around more or talk with other people more frequently to boost the number of steps or interactions for the purpose of not being judged, or showing their willingness to walk or socialize. In contrast, they might be reluctant to report every single trip and interaction they had during work hours, because they could be worried if other people would think that they were not concentrating on their jobs and not productive as well.

Another limitation is reliability and consistency of the instrument. Since the initial pedometers were low functioning, there were some issues at the beginning of the data collection such as broken pedometers. Therefore, the two different kinds of pedometers replaced a few of the original ones. For this reason, although most pedometers used for this research were the initial ones, there might be some chance to record different numbers of steps because of the differences in accuracy. In other words, this inconsistency from using the different kinds of pedometers might result in low reliability. For example, some pedometers might be more sensitive than others.

The questionnaire, one of the instruments for this research, also may have a low reliability, because a standard for completing the self-report forms and the questionnaire may be ambiguous. Since the questionnaire was developed with a five point Likert-type scale to record the participants' responses, it might be a subjective instrument to measure those questions. The degree of agreement with the statements in the questionnaire would differ from person to person.

As a final point, in this research, the distance was determined by assuming the path participants reported would be a shorter route according to the findings from the previous literature. However, the assumption that participants would use a shorter route might be wrong because their paths could be longer routes or they could have multiple destinations. If a participant usually has multiple destinations whenever he/she needs to go somewhere, and if the routes are established by those multiple destinations and not by considering the shorter routes used for defining the distance at all, then the distance actually followed for the trip would be completely different from the distance considered as the independent variable. Therefore, the distance calculated for this research might not be a strong independent variable nor affect the total number of steps.

Recommendations for Future Research

Based on both the implications and limitations of this research, several recommendations for future research can be suggested. Since using self-reports can result in low reliability, utilizing an objective measurement would greatly improve the reliability. Once an objective measurement is used for collecting routine data such as steps or interactions, then the participants will not have to put any effort into recording their data and they will be able to act as they normally do. Therefore, the collected data can represent their natural behavior. With the development of technology, there are a few possible objective measurements to quantify people's behavior such as interactions between people.

By conducting a triangulation method, consisting of an objective measurement and self-reports for collecting data of physical activity, the research can be more reliable because each measurement can compensate for the limitations. In addition, by comparing data from self-reports with ones from objective measurement, researchers can investigate whether the general perception about walkable distance corresponds with the actual walking distance. The workers' satisfaction and perceived comfort with the walking distance and the spatial layout can additionally be added to research.

Furthermore, collecting data about the number of interactions occurring outside a participant's workstation per day will provide another viewpoint of the relationship between the number of steps and interactions. As the study by Rashid et al. (2006) found results indicating that the majority of interactions take place in individual workspace, the interactions that occur at the participant's workstation have a tendency to happen while sitting. On the other hand, the interactions occurring outside his/her workstation usually occur while a participant is moving or has already moved. Therefore, having data about the interactions occurring outside his/her workstation will better explain the relationship between steps and interactions.

The last recommendation for future research is recruiting more than two different workplaces and conducting research with a large sample size. If future research recruits more than two work environments, then making comparisons among them, especially about environmental and organizational factors, will be possible. For instance, future research will be able to examine the differences in employees' behaviors between the office which has open-plan or private offices and/or the height of partitions (examples of environmental factors), the office which has flat or hierarchical work environments, retention of employees, and/or flexible or rigid work schedules (examples of organizational factors). In addition to that, by recruiting a large sample size, the spectrum of the participants will be broader. Therefore, future studies will be able to investigate the effects of different groups more thoroughly.

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APPENDIX A

Questionnaire

Q1. What is your opinion on the following?

	Strongly Disagree	Disagree	Neither Agree Nor Disagree	Agree	Strongly Agree
The job depends on the work of many different people for its completion.	1	2	3	4	5
The job involves a great deal of interaction with people outside my department.	1	2	3	4	5
I receive a great deal of information from my manager and co-workers about my job performance.	1	2	3	4	5
Other people in the organization, such as managers and co-workers, provide information about the effectiveness (e.g., quality and quantity) of my job performance.	1	2	3	4	5
I receive feedback on my performance from other people in my organization (such as my manager or co-workers).	1	2	3	4	5
I have the opportunity to develop close friendships in my job.	1	2	3	4	5
I have the chance in my job to get to know other people.	1	2	3	4	5
My supervisor is concerned about the welfare of the people that work for him/her.	1	2	3	4	5
People I work with are friendly.	1	2	3	4	5

Q2. What is your opinion on the following?

	Strongly Disagree	Disagree	Neither Agree Nor Disagree	Agree	Strongly Agree
The job gives me considerable opportunity for independence and freedom in how I do the work.	1	2	3	4	5
The job requires me to monitor a great deal of information.	1	2	3	4	5
The job requires unique ideas or solutions to problems.	1	2	3	4	5
The job requires me to utilize a variety of different skills in order to complete the work.	1	2	3	4	5
The job requires the performance of a wide range of tasks.	1	2	3	4	5
The job requires very specialized knowledge and skills.	1	2	3	4	5
The job provides me the chance to completely finish the pieces of work I begin.	1	2	3	4	5
The work activities themselves provide direct and clear information about the effectiveness (e.g., quality and quantity) of my job performance.	1	2	3	4	5

Q3. What is your opinion on the following?

	Strongly Disagree	Disagree	Neither Agree Nor Disagree	Agree	Strongly Agree
The seating arrangements on the job are adequate (e.g., ample opportunities to sit, comfortable chairs, good postural support).	1	2	3	4	5
The workplace allows for all different size for people in terms of clearance, reach, eye	1	2	3	4	5

	Strongly Disagree	Disagree	Neither Agree Nor Disagree	Agree	Strongly Agree
height, leg room, etc.					
The workplace is free from excessive noise.	1	2	3	4	5
The climate at the workplace is comfortable in terms of temperature.	1	2	3	4	5
The climate at the workplace is comfortable in terms of humidity.	1	2	3	4	5

Q4. Physical activity (e.g., walking, movement etc.) during the work is something…

	Strongly Disagree	Disagree	Neither Agree Nor Disagree	Agree	Strongly Agree
I do frequently.	1	2	3	4	5
I do automatically.	1	2	3	4	5
I do without having to consciously remember.	1	2	3	4	5
I do without thinking.	1	2	3	4	5
That belongs to my (daily, weekly, monthly) routine.	1	2	3	4	5
I start doing before I realize I am doing it.	1	2	3	4	5

Q5. I have no difficulties in walking.

Strongly Disagree	Disagree	Neither Agree Nor Disagree	Agree	Strongly Agree

Q6. Rank the places in order where you have conversation with coworkers during the day.

_______ Break room (Kitchen/Coffee room)
_______ Corridor
_______ Conference room
_______ Coworker(s)'s workstation
_______ Library
_______ Printer/Copy room
_______ Restroom
_______ Other: ____

Q7. What is your gender?

Male	Female
1	2

Q8. What is your age?

18-25 yr-old	26–35 yr-old	36–45 yr-old	46–55 yr-old	56 yr-old or more
1	2	3	4	5

Q9. How many years have you worked at this corporation?

Up to 2 years	2-5 years	6-10 years	11-20 years	21-30 years	More than 30 years
1	2	3	4	5	6

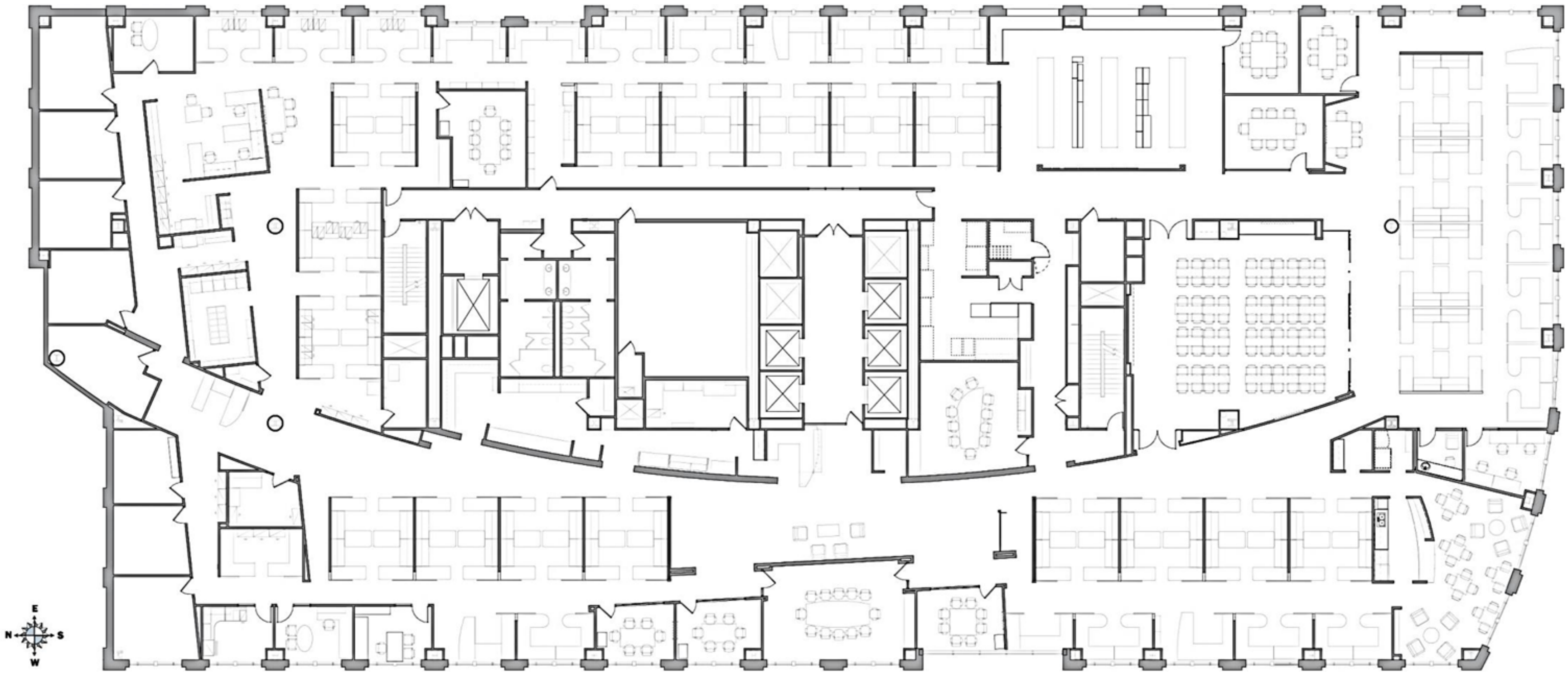
Thank you so much ☺

APPENDIX B

Daily Self-report Form

(Name) ____________________ (Date) ______________

Time (In)	Time (Out)	The number of steps (pedometer)



APPENDIX C

Instructions for Self-report Form

- ✓ Report every single trip whenever you make some physical movements (e.g., leaving your own workstation and coming back) and show your routes
- ✓ The destination should be represented with a dot
- ✓ If a trip has multiple destinations, a dot at each destination should contain the number of the destination's order (e.g., first destination will be represented as 1, second destination as 2, etc.)
- ✓ If you travel along the same path more than one time, you need to draw slash(s) (e.g., /, //, ///, etc., based on the number of trips) on the path
- ✓ For an interaction, you need to record every FACE-TO-FACE interaction
- ✓ If you have an interaction not seeing the other people (e.g., sending email, talking over the phone or a partition), you are not going to count them
- ✓ You need to draw stars beside destination representing as a dot whenever you have a face-to-face interaction while walking through the path
- ✓ If you have a face-to-face interaction at your workstation, put a star beside your workstation in the floor plan
- ✓ When you come to the office, you need to put on a pedometer on you for the entire work hours
- ✓ If you are out of the office for off-site meeting, lunch or working out, please put off your pedometer, and then when you come back to the office, put the pedometer back on you
- ✓ Report the time you come to the office and leave the office
- ✓ Report the number of steps on your pedometer when you leave the office
- ✓ When you need to take off early for part of a workday (e.g., meetings with clients or suppliers), please report the time you take off and the number of steps you have at that time
- ✓ Group interaction counts as a one interaction (e.g., having meetings or lunch with a group of people)

- ✓ Personal/Individual interaction occurred outside the group counts as an interaction (e.g. having meeting with a group of people, but talking with someone who is not a group counts two, because you are having conversation with a group and a new person outside of the group)