THE EFFECTS OF GENERIC AND TARGETED VISIBILITY ON WORK-PROCESS INTERACTIONS IN OPEN-PLAN OFFICES

A Ph.D. Dissertation

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GİZEM YENEL GÜLER

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THE DEPARTMENT OF
INTERIOR ARCHITECTURE AND ENVIRONMENTAL DESIGN
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By Gizem Yenel Güler

I certify that I have read this thesis and have found that it is fully adequate, in scope and in quality, as a thesis for the degree of Doctor of Philosophy in Interior Architecture and Environmental Design.

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ABSTRACT

THE EFFECTS OF GENERIC AND TARGETED VISIBILITY ON WORK-PROCESS INTERACTIONS IN OPEN-PLAN OFFICES

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Advisor: Prof. Dr. Halime Demirkan

June 2024

Visibility within open-plan offices plays a crucial role in shaping employee behaviors, including how they interact. The main aim of this thesis is to investigate the impacts of generic and targeted visibility on work-process interactions in open-plan offices. In the first phase, adopting a qualitative approach, this study aimed to detect work-process interaction patterns through a survey in two open-plan offices with 30 employees. Survey questions related to work-process interactions were analyzed through axial analysis. The second phase of the study, adopting a quantitative approach, was conducted through generic and targeted visibility analysis and new codes written for DepthMapX. The outputs of the two phases were analyzed to comprehend the influence of generic and targeted visibility on work-process interactions in open-plan offices.

The results showed that density values for 120° and 360° isovists are determinant factors for the number of work-process interactions in all generic and targeted visibility parameters. Moreover, a negative correlation was found between density

parameters and the number of work-process interactions. Therefore, it was found that more visible employees per unit in 120° and 360° isovists result in fewer work process interactions in open-plan offices. In other words, it was found that when an employee has a desk with low visual privacy or high visibility, this employee avoids interacting with their colleagues in open-plan offices. Therefore, the study's findings reveal that the impact of visual privacy on work-process interactions in open-plan offices is not as same as previously thought. In conclusion, the results of this study suggest that more visibility does not result in more work-process interactions in open-plan offices unless employees' visual privacy is preserved.

Keywords: Interaction, Open-plan Offices, Privacy, Space Syntax, Visibility

ÖZET

AÇIK OFİSLERDE GENEL VE HEDEFLENEN GÖRÜNÜRLÜĞÜN İŞ ETKİLEŞİMLERİ ÜZERİNE ETKİSİ

Yenel Güler, Gizem

Doktora, İç Mimarlık ve Çevre Tasarımı Bölümü

Tez Danışmanı: Prof. Dr. Halime Demirkan

Haziran 2024

Açık ofislerde görünürlük, etkileşim biçimleri de dahil olmak üzere çalışanların davranışlarını şekillendirmede önemli bir rol oynamaktadır. Bu tezin temel amacı, açık ofislerde genel ve hedeflenen görünürlüğün iş etkileşimleri üzerindeki etkilerini araştırmaktır. İlk aşamada nitel bir yaklaşım benimseyen bu çalışma, 30 çalışanın bulunduğu iki açık ofiste yapılan anket yoluyla iş etkileşim modellerini belirlemeyi amaçlamıştır. İş etkileşimlerine ilişkin anket soruları aksiyel analiz yoluyla incelenmiştir. Çalışmanın nicel bir yaklaşım benimseyen ikinci aşaması, genel ve hedeflenen görünürlük analizi ve DepthMapX için yazılan yeni kodlar ile yürütülmüştür. Bu iki aşamanın verileri, açık ofislerde genel ve hedeflenen görünürlüğün iş etkileşimleri üzerindeki etkisini anlamak için analiz edilmiştir. Sonuçlar, genel ve hedeflenen görünürlüğün tüm değişkenleri arasında, 120 ve 360 derece eş görüş alanlarına yönelik yoğunluk değerlerinin iş etkileşimlerinin sayısı için belirleyici faktörler olduğunu göstermiştir. Ayrıca, yoğunluk değişkeni ile iş etkileşimlerinin sayısı arasında negatif bir ilişki olduğu bulunmuştur. Bu nedenle,

120 ve 360 derece eş görüş alanlarında birim başına düşen görünür çalışan sayısı arttığında iş etkileşimlerinin azaldığı belirlenmiştir. Yani bir çalışanın görsel mahremiyeti az veya görünürlüğü yüksek bir masası olduğunda, bu çalışanın açık ofislerde meslektaşlarıyla etkileşimde bulunmaktan kaçındığı tespit edilmiştir. Bu yüzden çalışmanın bulguları, açık ofislerde görsel mahremiyetin iş etkileşimleri üzerindeki etkisinin önceki çalışmaların bulgularından farklı olduğunu ortaya koymaktadır. Sonuç olarak, bu çalışmanın sonuçları, çalışanların görsel mahremiyeti korunmadığı sürece açık ofislerdeki yüksek görünürlüğün daha fazla iş etkileşimi ile sonuçlanmadığını göstermektedir.

Anahtar Kelimeler: Açık Ofisler, Etkileşim, Görünürlük, Mahremiyet, Mekan Dizim

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LIST OF ABBREVIATIONS

ESM: Experience Sampling Method

IDE: Integrated Development Environment

MBI: Maslach Burnout Inventory

NWW: New Ways of Working

PWE: Physical Work Environments

R&D: Research and Development

SPSS: Statistical Package for Social Sciences

TAVAT: Targeted Visibility Analysis Tool

TVA: Targeted Visibility Analysis

TVI: Targeted Visibility Index

TVR: Targeted Visibility Ratio

VGA: Visibility Graph Analysis

CHAPTER 1

INTRODUCTION

Over time, office environments have evolved alongside advancements in information technology and the integration of collaborative practices into the workplace. Thus, these transformations have affected the workspace design since it was thought that physical office environments have to change accordingly if working ways change. Baker (1986) grouped physical factors of office environments under three headings: ambient factors (temperature, noise, and lighting), design factors (color, materials, pattern, texture, and layout of the office), and social factors (employees and customers). Using all these physical factors efficiently in office environments is vital to shaping employee behaviors and perceptions (Yıldırım et al., 2019).

Employees spend most of their time in their workspaces. They are directly affected by changes in their physical office environments (PWEs) that influence employee behavior in terms of productivity and efficiency (Larsen et al., 1998; Veitch & Gifford, 1996). PWE impacts interaction, communication, and collaboration (Boutellier et al., 2008; Hatch, 1987).

Designing more creative and cost-efficient workspaces has become necessary in the 21st century. Office design has transformed since the 20th century; however, the most notable change was the introduction of open-plan offices into workspace design (Mylonas & Carstairs, 2007). Open-plan offices are workspaces in which interior walls are nonexistent (Oldham & Brass, 1979), and they have been brought about by implementing collaboration and communication concepts in office environments. Eberhard and Wolfgang Schennel, two German consultants, introduced open offices into workspace design in the 1950s (Pierette et al., 2015). The objective was to establish more interconnected workspaces that facilitate employee interaction and communication (Pierette et al., 2015). Conversely, increased visibility in workspaces compromises visual privacy within open-plan offices. According to Sundstrom et al. (1980), there is a strong relationship between visual privacy and psychological privacy. Therefore, inadequate visual privacy negatively affects the environmental perceptions of employees. Likewise, there is evidence that spatial settings form work activities and work-process interactions (Hernes et al., 2006). Hence, in open-plan offices, the absence of visual privacy surpasses the benefits of interaction, communication, and collaboration. In open-plan offices, the potential influence of visual privacy on work-process interaction is still uncertain. Therefore, the study primarily addresses this gap using a computational method.

1.1. Problem Statement

Previous studies in the present literature showed that different methodologies, such as qualitative and quantitative research approaches, are both used to analyze visual

privacy issues in open-plan offices (Bergstörm et al., 2015; Blok et al., 2012; Haapakangas et al., 2018; Kim & de Dear, 2013; Laurence et al., 2013; Meinel et al., 2017). Although the methodologies of previous studies on privacy in offices differ, the instruments of these studies are primarily questionnaires and observation sheets. These instruments allow researchers to obtain employees' general opinions on their offices regarding visual privacy without concerning the location of employees' desks. Moreover, these studies did not evaluate the relationship between employees' answers related to visual privacy and the location of their desks in the office. In addition to conventional methods, a detailed analysis of layout offices is necessary to detect the reason for different visual privacy perceptions of employees in the same open-plan office. Thus, this thesis applies a computational approach through space syntax methodology, which analyzes spatial configurations in the built environment and ranks spaces by indicating social activities (Aknar & Atun, 2017). In addition, this methodology concentrates on the relationship between spatial layout and occupants' behaviors in the built environment and evaluates spaces according to their visibility (Lu & Seo, 2015). As physical invisibility is necessary in order to have enough visual privacy in spaces, the space syntax methodology is one of the methods to evaluate visual privacy quantitatively in spaces (Garvey, 2005). Visibility can be categorized into two types: generic visibility and targeted visibility. Meanwhile, generic visibility encompasses all areas of space visible from any given location within a setting. Three spatial metrics are used in this thesis to perform generic visibility analysis in the built environment. First, degree indicates the number of visible people within the 360° field of vision. Second, density indicates the number of people per square meter and is calculated by the ratio of the degree to the 360° field of vision (Sailer et al., 2021). Last, visual integration measures the visual

distance from all spaces to all others (Hillier, 2007). On the other hand, targeted visibility focuses on particular visual objects and their visibility. Three spatial metrics are used in this thesis to perform targeted visibility analysis. First, outdegree indicates the number of visible people within the 120° field of vision. Second, binocular density indicates the number of people per square meter and is calculated by the ratio of the outdegree to the 120° field of vision (Sailer et al., 2021). Last, TVR represents the ratio of the number of visible employees (sitting and moving) within a 120° field of vision. Social distance (150 cm) and personal distance (60 cm) were taken into consideration in order to understand if different distances affected targeted visibility values (Hall, 1969). Personal distance refers to interactions among familiar individuals like colleagues and friends, while social distance pertains to formal relationships, such as those found in business conversations (Cristani et al., 2013).

Prior research on visual privacy and open-plan offices primarily focuses on the attributes of generic visibility. Consequently, this thesis delves into both generic and targeted visibility within open-plan offices to detect the impacts of visual privacy on work-process interactions (see Figure 1).

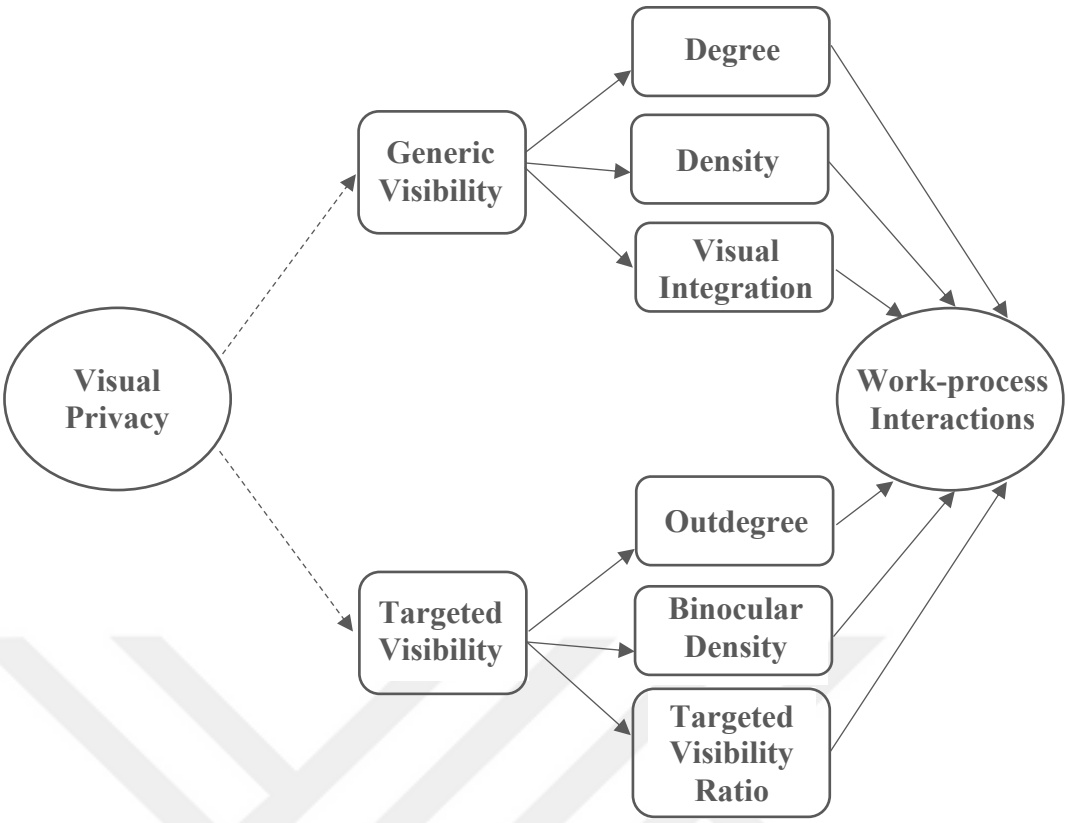


Figure 1. Conceptual model illustrating how visual privacy impacts work-process interactions

1.2. Aim and Scope

This thesis aims to encompass: (i) examining the correlation between visual privacy and work-process interactions in open-plan offices using both generic and targeted visibility; (ii) determining which analyses, specifically generic visibility and targeted visibility, correlate with patterns of work-process interactions in these environments; (iii) showcasing the practical utility of visibility analysis in open-plan offices; and (iv) focusing on both generic and targeted visibility to analyze visual privacy and interaction dynamics within these settings.

The research has two phases. The first phase is a qualitative research approach through observation and a survey. The second phase is a quantitative research approach through generic and targeted visibility analysis. The outputs of both qualitative and quantitative research were combined and analyzed to explore the impacts of generic and targeted visibility on work-process interactions.

By addressing the influences of visibility on work-process interactions, this study is distinguished from prior research on visual privacy in open-plan offices that primarily concentrate on generic visibility (Rashid et al., 2009). Moreover, most studies in targeted visibility primarily deal with hospitals and museums (Peponis et al., 2004; Lu & Zimring, 2012). However, visibility studies in the built environment place less emphasis on the targeted visibility of office environments. Visual privacy and visibility studies in offices mainly use traditional rather than computational approaches (Kim & de Dear, 2013; Bergstörm et al., 2015; Meinel et al., 2017). Also, there are limited studies to design a new tool to measure targeted visibility (Lu, 2010; Markhede et al., 2010). Therefore, addressing how visual privacy affects work-process interactions through generic and targeted visibility analyses and a computational approach, which has not been studied in previous studies, is a valuable contribution to theory and practice.

1.3. Structure of the Thesis

This thesis consists of seven chapters. The first chapter explains the background of the study and consists of information on the research problem, aims, research

questions, hypotheses, and significance of the thesis. Two chapters following the introductory chapter focus on the relevant literature.

The second chapter is about office environments. Literature focusing on the open-plan office concept is presented in this chapter with its definitions, advantages, and disadvantages. In addition, the second chapter presents environmental dimensions of office environments like personal spaces, territoriality, crowding, privacy, and three different work privacy concepts. Moreover, interaction in office environments with its definitions, types, and various measurements are presented in this chapter.

The third chapter includes a methodological review of prior research concerning privacy and open-plan offices. Research gaps in prior research are also addressed in this chapter. Moreover, visibility analysis through space syntax methodology is presented in this chapter.

The fourth chapter presents the methodology of the thesis with its aims, research questions, hypotheses, and proposed framework. Moreover, the study's settings, participants, and instruments like observation sheets, surveys, DepthMap software, written codes in Python, and the study’s procedure containing both qualitative and quantitative data collection are presented in the fourth chapter. Pilot studies performed to gain prior experience with the software are also presented.

The fifth chapter presents qualitative findings from observation and survey and quantitative findings from the axial analysis, generic and targeted visibility analysis. The results of two open-plan offices are also combined and represented in this chapter. This chapter also includes statistical analysis of these combined data through Statistical Package for Social Sciences (SPSS).

In the sixth chapter, the discussion section is presented. The results of both qualitative and quantitative research are discussed in this chapter. Obtained quantitative results are discussed under six different concepts in this chapter.

The seventh chapter concludes the findings of the thesis by underlining its limitations and suggestions for further research. Furthermore, this chapter introduces new design guidelines for open-plan offices focusing on work-process interactions and visual privacy. All written and visual documents, codes, and detailed statistical tables are presented in the appendices.

CHAPTER 2

OFFICE ENVIRONMENTS

This study reviews the existing literature focusing on office environments, especially open-plan offices. Environmental dimensions of office environments comprising personal space, territoriality, crowding, privacy, and interaction in office environments are discussed to pose the study's research questions.

2.1. Open-plan Offices

The primary concept behind the open-plan office is to establish workspaces separated by furniture or partitions rather than walls (Pile, 1978). Partitions are extensively utilized in open-plan offices to establish smaller work zones (Hedge, 1982). Sundstrom (1986) defined open-plan offices as combined workspaces that contain open work areas and private offices. According to Sundstrom (1986), open-plan offices consist of rooms for four or five employees, and their workstations are replaced by minimal visual barriers between employees. Moreover, individual workspaces within an open-plan office are situated in a shared, open environment (Smith Jackson & Klein, 2009). These offices have flexible and innovative workspaces (McElroy & Morrow, 2010). The primary aims of this office layout

include ensuring that each employee participates equally in work-related tasks and fostering improved communication among employees (Sundstrom, 1986). Also, increased collaboration among employees is aimed at open-plan offices in contrast to traditional offices (Allen & Henn, 2007). Implementing integrated workspaces and open-plan offices offered benefits and drawbacks to employees' perceptions of their environment. Employees benefit positively from the integration of workspaces within open-plan offices (Table 1).

Table 1. Advantages of open-plan offices

Advantages of Open-plan Offices	**Studies (Author Surname, Date)**
Communication, Interaction	Allen & Gerstberger, 1973; Kim & de Dear, 2013; Kupritz, 2003; Sundstrom, 1986
Collaboration, Teamwork Opportunities	Allen & Henn, 2007; Ding, 2008; Fayard & Weeks, 2007
Knowledge sharing	Boutellier et al., 2008
Flexibility, Cost-saving	Brennan et al., 2002; Brunia et al., 2016; Hedge, 1982; McElroy & Morrow, 2010; Pejtersen et al., 2006; Yıldırım et al., 2019
Creativity	D'Angelo Fisher, 2013
Increased cognitive task performance	Bridger & Brasher, 2011

According to Kupritz (2003), open offices increase communication and interaction among employees because of integrated workspaces. Ding (2008) additionally notes

that employees prefer open-plan offices due to increased possibilities for collaboration. Likewise, there is evidence that eliminating visual barriers and interior walls increased communication and positively affected employees' perceptions (Allen & Gerstberger, 1973; Kim & de Dear, 2013). Also, unplanned and spontaneous interactions increased collaboration activities in open-plan offices (Fayard & Weeks, 2007). Consequently, open-plan offices fostered an increase in knowledge transformation among employees (Boutellier et al., 2008). The unique layout of open-plan offices also transformed lighting configurations because these new office environments are open and separated with partitions and furniture instead of walls (Yıldırım et al., 2019). Flexibility and cost-saving are other advantages of open-plan offices as a consequence of the use of fewer walls than conventional offices (Brunia et al., 2016). Open-plan offices introduced flexible spaces that employees could easily modify and change their workspaces (Yıldırım et al., 2019). According to Hedge (1982), open-plan offices reduced rental and land costs. Employees in these offices occupy fewer square meters by eliminating interior walls (Brennan et al., 2002). Therefore, many companies have changed their traditional offices to open-plan offices because of the lower costs (Pejtersen et al., 2006). According to D'Angelo Fisher (2013), open-plan offices also boosted employee creativity due to the presence of adjustable workspaces. Also, these offices meet cognitive task demands (Bridger & Brasher, 2011).

Conversely, unclear divisions within open-plan offices have a negative impact on employees' environmental perceptions (see Table 2). Hedge (1982) demonstrated that open-plan offices trigger low privacy, high distraction, and noise. Other studies also mentioned that lack of privacy and increased distractions/interruptions negatively

influence employee perceptions (Block & Stokes, 1989; Cangelosi & Lemoine, 1988). In addition, the lack of privacy results in increased territoriality of employees (Altman, 1975). The reason for the territorial behaviors of employees is to maintain control over the workspace (Ayoko & Härtel, 2003).

Table 2. Drawbacks of open-plan offices

Drawbacks of Open-plan Offices	**Studies (Author Surname, Date)**
Lack of privacy, high distraction/noise	Block & Stokes, 1989; Cangelosi & Lemoine, 1988; Hedge, 1982
Uncertainty about the possession of space	Altman, 1975; Ayoko & Härtel, 2003; Brown, 2009; Danielsson et al., 2015; Kimmons & Austin, 2012;
Mental workload	De Croon et al., 2005
Discomfort with working environments	Kim & de Dear, 2013
Diminished mental and physical health	Danielsson & Bodin, 2008; Haapakangas et al., 2018
Decrease in motivation and productivity	Brennan et al., 2002

Likewise, according to Brown (2009), employees could be involved in territorial behaviors to increase privacy in their workspaces because uncertainty about the possession of space occurs in open-plan offices due to uncertain divisions (Kimmons & Austin, 2012). Conflicts arise in open-plan offices because of inadequate privacy,

noise, and interruptions (Danielsson et al., 2015). Also, there is an observed increase in cognitive workload within open-plan office environments (De Croon et al., 2005). Inadequate privacy reduced employee productivity, motivation, and satisfaction after moving to an open-plan office from a traditional office (Brennan et al., 2002). According to Kim and de Dear (2013), dissatisfaction with workspaces is one of the disadvantages of open-plan office layouts because of increased noise and decreased privacy. These disadvantages of open-plan offices for employees dominate their interaction and collaboration advantages (Kim & de Dear, 2013). Moreover, open-plan offices negatively affect psychological and physical well-being (Danielsson & Bodin, 2008). The absence of privacy impacts not just employees' satisfaction but also their job performance and mental and physical health. (Haapakangas et al., 2018).

2.2. Environmental Dimensions of Office Environments

People use physical environments according to preferences that could occur unconsciously. In order to understand the reasons for these unconscious preferences, some concepts become vital to analyze. Personal space, territoriality, and crowding are the most critical dimensions of social space to examine the use of physical environments and perceptions of occupants, and they are strongly linked to privacy (Gifford, 2014).

2.2.1. Personal Space in Office Environments

According to Robert Sommer (1969, p. 26), “personal space is an area with invisible boundaries surrounding a person’s body into which intruders could not come.” Personal space in the office environment refers to the physical zone employees protect in order to prevent invasions that can affect stress levels (Hayduk, 1978). Inadequate space in the office environment negatively affects the environmental perceptions of employees. Also, the more employees feel space scarcity in their workspaces, the more they try to preserve and defend their personal space (Zoghbi-Manrique-de-Lara & Sharifiatashgah, 2019). When the personal spaces of employees are invaded, they feel crowded and uncomfortable in the office environment (Hall, 1966). Therefore, when the invasion of personal space exceeds employees’ comfort levels, lack of privacy and crowdedness are experienced in open-plan offices (Kamarulzaman et al., 2011). Experienced crowdedness and lack of privacy result in dissatisfaction with work workspaces and negative employee perceptions of their office environments (Oldham & Rotchford, 1983). Inadequate personal space and undesirable interaction in workspaces are two aspects that impact privacy (Chan, 1999). Moreover, invading personal spaces in the office environment leads employees to develop territorial behaviors.

2.2.2. Territoriality in Office Environments

According to Malmberg (1980), territoriality proves the social function of people because it indicates who owns space or object. “Territoriality is a pattern of behavior and attitudes held by an individual or group based on perceived, attempted, or actual

control of a definable physical space, object, or idea involving habitual occupation, defense, personalization, and marking" (Gifford, 2012, p. 56).

Territorial behaviors derive from a desire to control space or an object (Ayoko & Härtel, 2003). Territoriality occurs as a result of a feeling of ownership of a place or an object (Brown et al., 2005). Psychological ownership influences territoriality and permits people to express their identity (Pierce et al., 2001). The invasion of territoriality is one of the biggest problems in the built environment. Territorial invasions occur when another person gets into one's territory (Brown & Robinson, 2011). Territorial invasions appear mostly in open-plan offices in contrast to conventional offices (Zalesny & Farace, 1987). According to Monaghan and Ayoko (2019), open-plan office layouts affect the territorial behaviors of employees and how the invasion of territoriality is understood. Therefore, there is evidence that open-plan offices trigger conflicts over the ownership of workspaces (Kimmons & Austin, 2012). Likewise, the lack of privacy in open-plan offices is a significant reason for the territorial behaviors of employees (Altman, 1975).

2.2.3. Crowding in Office Environments

Crowding is a person's experience of the number of other people around (Gifford, 2014). Crowding is a subjective expression. Thus, it depends on personal, cultural, and situational factors. Perceived crowding is a negative environmental perception of uncontrolled social contact (Altman, 1975). Crowding is frequently confused with density. On the other hand, density measures people per unit area. Therefore, density is an objective measure to decide the number of people per unit of area (Gifford,

2014). In other words, crowding is people's psychological reaction to density (Stokols, 1972). Crowding is experienced by employees in the office environments when density in workspaces increases. Therefore, employees perceive crowding around their workspaces when inadequate personal space is experienced in open-plan offices (Altman, 1975). As a consequence of crowding in an office environment, employees feel they lost work-related resources to their colleagues (Hobfoll, 1989). Also, loss of privacy in open-plan offices triggers employees to develop negative feelings about their workspaces due to crowding in the office environment (Zoghbi-Manrique-de-Lara & Sharifiatashgah, 2019).

2.2.4. Privacy in Office Environments

According to Altman (1975), “privacy is selective control of access to the self or one’s group” (p. 18). Moreover, as defined by Meinel et al. (2017), it refers to the potential to be secluded from the presence of others. Privacy also means managing information transfer from oneself to others and from others to oneself (Marshall, 1972; Margulis, 1977). According to these definitions of privacy, individuals strive to maintain an optimal level of connection with others. In addition, people try not to meet unsatisfied outcomes of situations that exceed the optimum social contact levels (Sundstrom, 1977). To limit unfavorable environmental perceptions, occupants should maintain social contact, as inadequate social interaction could lead to feelings of isolation (Wohlwill, 1974); social contact at a more-than-optimum level could influence crowding (Sundstrom, 1978). Privacy can be classified into two types: architectural and psychological privacy.

Architectural privacy is further categorized into two subtypes: visual privacy and acoustical privacy. For instance, conventional offices featuring individual workspaces separated by walls offer considerable architectural privacy. On the contrary, there is a reduced level of privacy in an open-plan office where workspaces are divided by partitions or furniture. Conversely, psychological privacy arises from the sense of controlling access to oneself (Altman, 1975). The degree of architectural privacy can influence psychological privacy. For instance, employees in cellular offices have greater control over social interactions, whereas those in open-plan offices cannot manage their accessibility (Sundstrom et al., 1980).

Altman also divided privacy as desired privacy and achieved privacy. Desired privacy refers to a person or group's desired level of privacy, while achieved privacy refers to the actual level. In a successful privacy system, the achieved privacy equals the desired privacy. Employees experience stress and discomfort in their workspaces if it is not equal. Having achieved privacy more than desired privacy represents having too much privacy. In other words, having too much privacy occurs when people are subjected to more information than desired. When people maintain the desired input and output level, privacy control is obtained. Having too little privacy indicates an invasion of privacy, while too much privacy results in loneliness, isolation, and boredom (Altman, 1976). On the other hand, achieving less than desired privacy illustrates having too little privacy. Within these cases, having too little privacy is the subject of this study because the loss of privacy remains an unresolved problem in open-plan offices (Altman, 1976).

Invasion of privacy, which is highly linked to invasion of personal space and crowding perceptions, is a vital problem in open-plan offices due to uncertain divisions between workspaces (Worchel & Teddie, 1976). Crowding perceptions occur when people encounter undesirable and uncontrolled interactions (Saegert, 1978; Stokols, 1972). In open-plan offices, employees identify crowding as a lack of resources related to the physical office environment and a lack of control over personal boundaries in the office environment. Therefore, employees experience uncomfortable situations in their workspaces due to social contact that they cannot control. Then, in order to preserve their boundaries (personal spaces) at work, they would develop a mechanism by limiting their boundaries (territoriality). In the end, employees experience an invasion of privacy at work as a result of crowding and inadequate personal spaces. Following privacy intrusion, employees develop territorial behaviors in their workspaces as a reaction (Zoghbi-Manrique-de-Lara & Sharifiatashgah, 2019).

Three different work privacy concepts based on Altman's privacy definition are selected and reviewed in this study in order to understand different perspectives on work privacy.

2.2.4.1. Sundstrom's Work Privacy Concept

Sundstrom's concept of privacy is associated with the field of psychology. According to Sundstrom et al. (1980), work privacy is strongly correlated with physical enclosure and perceived privacy. In other words, perceived privacy is deeply affected by the physical characteristics of a workspace that enable employees

to control visual and auditory information transfer to other employees (Sundstrom et al., 1982a). In this regard, the number of closed sides is the primary determinant of workspace privacy, and most private workspaces are fully enclosed offices (Sundstrom et al., 1980; Sundstrom et al., 1982a). In addition, when physical enclosure increases in offices, employees become more satisfied with their workspaces (Sundstrom et al., 1982b). On the other hand, according to Sundstrom et al. (1982a), perceived privacy could differ from one job type to another because of social norms.

Regarding Sundstrom's work privacy (1977), employees attempt to preserve the optimum level of social contact and avoid unsatisfied consequences of situations that are not defined as optimal. Not exceeding the optimal level of social contact prevents employees from experiencing crowding in their office environments (Sundstrom, 1978). Likewise, there is an inverse relationship between the complexity of the job and the required social contact. In contrast to employees with routine jobs, employees who perform complex tasks in their office environments desire to avoid distraction and noise in their workspaces (Sundstrom et al., 1980).

Sundstrom et al. (1982a) listed three essential items to maintain privacy at work: management of social contact, control over distraction and noise, and autonomy from supervision. According to Sundstrom (1986), an increase in noise and a decrease in privacy in an office environment need to be controlled because employees' work performance and job satisfaction decrease when they are subjected to a certain level of noise in their office environment. As a consequence of his study, Sundstrom also

claimed that the most crucial part of privacy is holding private conversations in offices (Sundstrom et al., 1982b).

2.2.4.2. Burgoon's Work Privacy Concept

Burgoon's concept of privacy is associated with the field of communication. Burgoon's work privacy concept (1982) is applicable to communication research. The author mentions different social relationships, which are essential to discovering communication's importance under privacy invasion (Burgoon, 1982). Also, according to Burgoon (1982), the relationship between communication and privacy needs to be examined. The invasion of privacy is strongly related to different kinds of social relationships in that the invasion takes place (Burgoon, 1982). Therefore, Burgoon's work privacy (1982) definition mainly focuses on social relationships. Burgoon mentions four dimensions of privacy that have inferences about communication: physical, social, psychological, and informational. Physical privacy is the level at which people are unreachable to others. In other words, physical privacy requires the elimination of invasion of privacy around body buffer zones defined by people (Burgoon, 1982). By underlining the communication part of privacy, Burgoon claims (1982) that the type of relationship is a determinant factor that influences feelings of loss of privacy. Relationships maintained in the highest or lowest respect create feelings of low privacy loss. In contrast, relationships kept in medium respect create high levels of privacy loss for people. Social privacy is a reasonable result of physical privacy. All attempts of people to preserve the level of social contact on an individual and group level are parts of social privacy. For example, like individuals, groups tend to create boundaries to separate themselves from a large group of society (Burgoon, 1982). They aim to create distance from

other people in order to reach higher intimacy within their groups. As stated by Burgoon (1982), the third type of privacy is psychological privacy, which deals with the ability of people to preserve powerful and cognitive inputs and outputs. Consequently, psychological privacy only deals with individuals, not with groups. Psychological privacy has essential effects on communication through its functions: development of self-identity, self-evaluation, self-protection, personal autonomy, and personal growth (Burgoon, 1982). The last type of Burgoon's privacy (1982) is informational privacy, the right to decide when, how, and how much information about themselves is transferred to other people. Information privacy is violated when data about people is shared with another individual or group without permission (Burgoon, 1982).

2.2.4.3. Kupritz's Work Privacy Concept

Kupritz's concept of privacy is associated with communication and environmental psychology. According to Kupritz (1998), privacy manages interaction among people, others, and environmental stimuli. Kupritz (1998) emphasizes that privacy reflects three main themes of social behavior: management of interaction, retreat from other people, and control over information. Work privacy mainly emphasizes the management of the interaction part of privacy, also named information management (Kupritz, 1998). Kupritz (1998) stated that controlling information and employees' ability to manage interaction help them restrict exchange with other people. Kupritz (1998) also mentions five needs of privacy: control over social contact, avoiding crowding, elimination of distraction and noise, autonomy, and conversational privacy.

Kupritz (2000) stated that environmental, behavioral, and social mechanisms play a vital role in managing work privacy. Kupritz (2000) highlights that these mechanisms are needed to be analyzed under cultural circumstances. Environmental mechanisms are physical barriers (walls, partitions, and furniture) and field characteristics (intensity of light, sound, and air quality) (Kupritz, 2000). Behavioral mechanisms are overt behaviors (territorial behaviors and verbal/nonverbal behaviors) and cognitive behaviors (adaptation and distinguished people control) (Kupritz, 2000). Social mechanisms are formal policies and social norms that define people's behavior (Kupritz, 2000). Kupritz (2000) states that all these mechanisms are logical when examined within a cultural context: values, beliefs, and language patterns.

In one of her studies, Kupritz (2011) discovered four characteristics of architectural privacy that consist of both group and individual work: (1) having higher partitions for individual workspaces, (2) having an individual workspace far from the crowded circulation areas in the office, (3) having higher partitions for group workspaces, (4) design of private areas for group works.

2.2.4.4. Visual Privacy in Open-plan Offices

The unintentional consequence of having others nearby or their activities is a lack of visual privacy (Brill et al., 1985). This loss of visual privacy can negatively impact employees in open-plan offices by reducing their sense of control, satisfaction, and productivity. Brand and Smith (2005) argue that as the level of enclosure decreases in these settings, employees experience undesirable observation, leading to a loss of

control over their workspace. Supporting this, Maher and von Hippel (2005) conducted a study investigating how perceived privacy affects employee satisfaction and performance in open-plan offices. Their findings align with those of Brand and Smith (2005), showing that low perceived privacy, characterized by inadequate personal space and undesirable interactions, negatively impacts employee satisfaction and work performance (Maher & von Hippel, 2005). Consequently, employees establish negative attitudes toward their office environment due to the lack of control over interactions (Maher & von Hippel, 2005). Moreover, employees were surveyed about their satisfaction with their workspace to explore the correlation between privacy and employee well-being in the study of Ding (2008) on user preferences in open-plan offices. It was found that loss of privacy makes employees feel unsatisfied with their current workspace (Ding, 2008). Employees also stated that they want to change and control their workspaces when they think their visual privacy has started to be invaded (Ding, 2008). In addition, Kim and de Dear (2013) conducted an occupant survey in order to investigate the relationship between employee satisfaction and office layout. They discovered that lack of privacy was the main reason for dissatisfaction with workspaces (Kim & de Dear, 2013). In other words, visual privacy is the foremost preference of employees in open-plan offices (Kim & de Dear, 2013). Kim and de Dear (2013) also underlined that increasing individual workspaces in open-plan offices increases employee satisfaction. Moreover, there is evidence that dissatisfaction with privacy overshadowed improved communication in open-plan offices (Kim & de Dear, 2013).

According to previous studies, in open-plan offices, visual privacy is a significant factor in employees' job satisfaction and work performance. Furthermore, the

absence of visual privacy undermines the primary benefit of open-plan offices: interaction (Kim & Dear, 2013). Hence, grasping the meaning of interaction within office environments becomes crucial.

2.3. Interaction in Office Environments

Innovation becomes extremely important in contemporary organizations due to competitiveness, and therefore, companies primarily motivate their employees to develop innovative behavior during work processes (Greve & Taylor, 2000). Innovative behavior in office environments means creating original and valuable ideas, spreading these ideas to other colleagues, and implementing those ideas (Parker et al., 2006). The first step of innovative behavior in office environments is producing ideas. Employees think, explore and identify ideas individually during this step (Ng & Wang, 2019). Conversely, the dissemination and implementation of ideas within offices are social processes requiring employees to collaborate and share their ideas (Baer, 2012). Consequently, for effective task performance and idea exchange, employees must engage in interactions with their colleagues in office environments (Peponis et al., 2007).

As mentioned above, interaction is an inevitable outcome of innovative behavior, and organizational scholars mentioned that collaboration and interaction at work are essential (Katz & Kahn, 1966; Organ, 1988). Enhanced employee interaction offers benefits to work processes. Heightened interaction leads to more efficient employees when employees engage in collaboration and support each other (Whiting et al., 2008). Consequently, with more efficient team members, there is a boost in the

overall effectiveness of teams or work units (Koys, 2001). Further, the helpful behavior of employees at work (increased interaction) positively affects the development of social capital (Bolino et al., 2002). Also, according to Dimotakis et al. (2011), interpersonal interactions at work are strongly correlated with the individual well-being of employees at work. They stated that positive interactions with other employees at work positively affect employees' moods and increase their job performance (Dimotakis et al., 2011). Further, positive interpersonal interactions increase employees' job satisfaction, while negative interactions decrease job satisfaction (Dimotakis et al., 2011).

In office environments, two primary types of interactions occur: social interactions stemming from personal preferences and work-process interactions, which are more compulsory. They are also classified as informal interactions (social interactions) and formal interactions (work-process interactions) (Peponis et al., 2007). According to their purposes, work-process interactions are divided into four: interactions related to expert advice, improvement, decision-making, and innovation (Peponis et al., 2007). Furthermore, another classification categorizes work-process interactions as intra-team and inter-team (Wohlers & Hertel, 2017). Intra-team interactions define the relationship among employees in the same team or department. In contrast, inter-team interactions are relationships among employees in different teams or departments (Wohlers & Hertel, 2017). Moreover, office environment interactions are categorized into two groups: planned and unplanned. Planned interactions take place in meeting rooms and employee workspaces. They are scheduled before interaction takes place. On the other hand, unplanned interactions can occur everywhere while employees walk around the office (Hillier et al., 1984). Unplanned

interactions are likely to occur within a short period and occur daily. Planned interactions mainly occur weekly, monthly, or yearly (Peponis et al., 2007).

Cross et al. (2002) divide interaction networks into five categories: communication network, information network, problem-solving network, know network, and access network. First, a communication network refers to the informal structure of offices. It contains daily informal interactions. Asking employees with which colleagues they communicate about non-work-related subjects helps to identify the communication network in office environments. The communication network provides a clue about the organization's social structure and identifies sub-groups inside office spaces. Second, an information network defines who interacts with whom in order to get some advice related to the work process. Asking employees from whom they get work-related information detects the information network in office environments. Third, a problem-solving network shows who connects with whom to solve problems related to the work processes. Asking employees which colleagues are influential in solving their work-related problems identifies the problem-solving network in office environments. The fourth network is a know network that identifies who knows whose working knowledge. Asking employees whose knowledge and skills they are aware of detects the know network in office environments. Last, an access network defines who has access to whose expertise. Asking employees which colleagues are accessible when they need knowledge represents the access network in office environments (Cross et al., 2002). This thesis concentrates on work-process interactions (formal interaction) to detect visual privacy effects within all these interaction types.

Peponis et al. (2007) mention two ways to measure interaction in office environments: space syntax and social network analysis. Space syntax describes building layouts quantitatively (see Section 3.2 on page 32). Two spatial analysis methods are used to measure interaction in office environments. The first spatial analysis method is the linear integration map. For this method, the fewest and longest lines are drawn to connect all spaces, complete all circulation roads, and arrive at each workspace in the office environment. The number of intersections with other lines in the plan layout determines the connectivity level of drawn lines. More intersected lines are represented thicker and indicate more interaction on the plan (Figure 2).

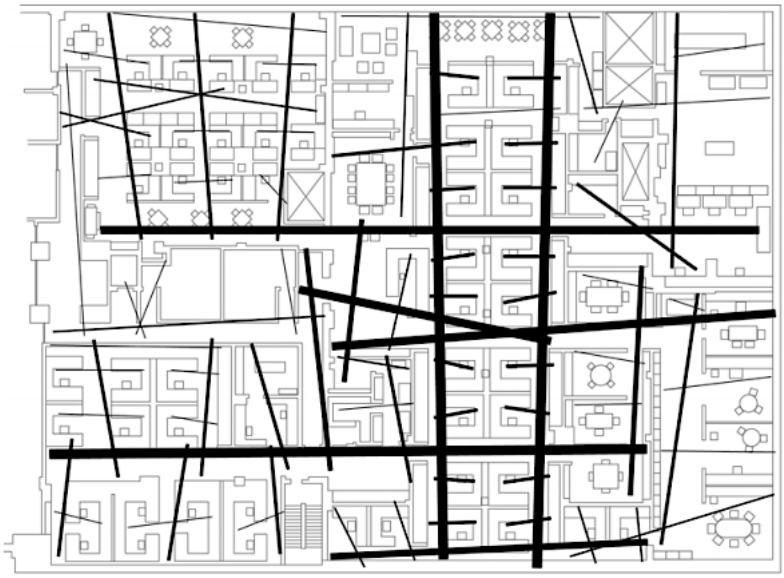


Figure 2. A map showing linear integrations in an office environment (Peponis et al., 2007)

The second spatial analysis method is visibility polygon analysis (Peponis et al., 2007). For this method, visibility polygons are indicated for each grid including all

visible areas on the plan. For this explanation, visible areas refer to all other points connected to a selected point on the plan without any boundary. The findings of polygon analysis are both colored diagrams and numerical data. Colored diagrams are evaluated according to light and dark colors on the plan. Lighter areas indicate more interaction and darker colors indicate less interaction, as shown in Figure 3.

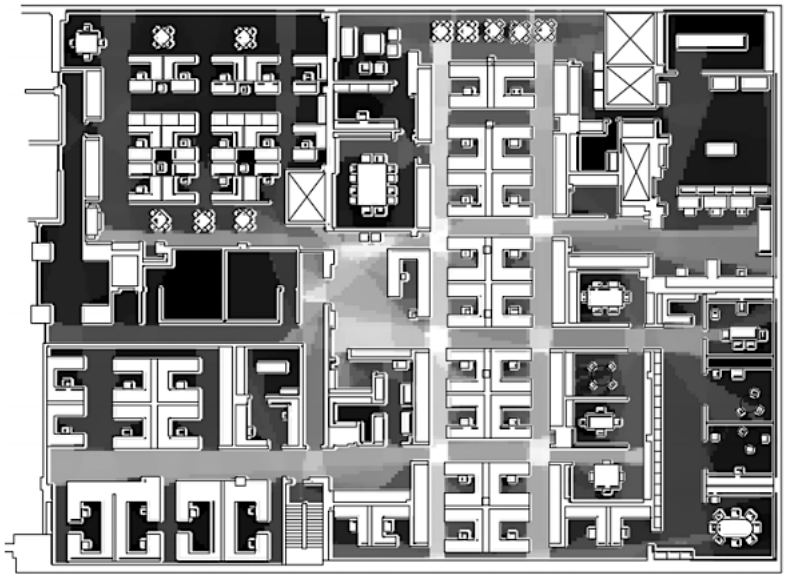


Figure 3. Polygon analysis of an office environment (Peponis et al., 2007)

According to Peponis et al. (2007), the second way to measure interaction in office environments is social network analysis, which describes patterns of interaction by employees. The first part of the social network analysis is a self-assessment questionnaire formed to detect perceptions of four affordances in offices. Employees are asked Likert Scale questions related to four affordances: access to team workspaces, access to individual workspaces, access to informal gathering spaces, and the presence of natural light and views (Peponis et al., 2007). This questionnaire aims to understand the perceptions of employees in workspaces. Following self-

assessment questionnaires, interaction network data is analyzed based on questionnaires. In order to gather interaction network data, employees are asked with whom they interact on a daily, weekly, monthly, quarterly, and yearly basis. The interaction types mentioned above – informal interactions, formal interactions, and interactions related to expert advice, improvement, decision-making, and innovation – are examined within a specific period. The density measure is used for interaction network analysis and helps to identify whether the interaction is frequent or less frequent (Peponis et al., 2007). Daily and weekly interactions are categorized as frequent, while monthly, quarterly, and yearly interactions are classified as less frequent (Peponis et al., 2007).

Another method to analyze interaction patterns and their location is the experience sampling method (ESM) (Weijs-Perree et al., 2020). It analyzes interactions and gathers a representative sample of human behavior (Fisher & To, 2012). In other words, this research procedure helps record people's thoughts and feelings (Larson & Csikzentmihalyi, 2014). ESM gathers self-reports related to a specific topic. Signals were sent to participants at random times. Following these signals, participants received an online survey in order to report their interactions. They reported interactions that took place in their office environment. This method reduces memory mistakes because respondents notify when actions occur (Weijs-Perree et al., 2020).

In order to analyze and discover the interaction behavior of employees, two different design models are applied to open-plan offices: flow and serendipitous model (Peponis et al., 2007). Both models support the notion that the design of office

spaces affects communication and information exchange among employees. The flow model asserts that integration levels increase when office environments are designed in alignment with the information circulation (Peponis et al., 2007). For instance, employees who need to communicate more must be placed close. However, the office layout becomes uncertain if employees need to communicate with too many colleagues. According to the serendipitous model, the design of informal gathering spaces such as cafés and relaxing areas increases interaction (Peponis et al., 2007). On the other hand, this design model affects unplanned interaction in offices. Peponis et al. (2007) suggested that architects move beyond these two models and find new design models for office interaction.

As previously noted, open-plan offices emerged from concepts emphasizing interaction in workspaces (Oldham & Brass, 1979). However, the primary disadvantage of open-plan offices is the absence of visual privacy. Hence, this thesis seeks to explore the potential impacts of visual privacy on work-process interactions within open-plan offices.

2.4. Methodological Extensions of Open-plan Offices

Prior studies have been methodically reviewed to uncover privacy concerns within open-plan offices (see Table 3). Some office studies used qualitative research methods. Meinel et al. (2017) used a systematic review process by analyzing existing articles in terms of subjects, journals, hypotheses, and levels of analysis. They researched how to design innovative office environments. Existing empirical research on creativity-enhancing workspaces is overviewed using some keywords:

creativity and innovation as dependent variables. Studies containing these keywords and their effects on the physical office environment were selected for this study. Empirical evidence gained through previous studies proved that workspaces enhance the creativity of employees when they are designed accordingly.

Another methodology that researchers used to analyze offices is quantitative research. Kim and de Dear (2013) used an occupant survey questionnaire with close-ended questions as an instrument to investigate the relationship between the positive effects of the advantages of open-plan offices and the negative effects of the disadvantages of open-plan offices in terms of employee satisfaction. They also aimed to examine the behavior of employees for changing indoor environment quality and their relation to different office layouts. The occupant survey questionnaire covers thermal comfort, air quality, lighting, acoustic quality, office layout, office furnishings, cleanliness, maintenance, and overall satisfaction.

Table 3. Previous methods and tools associated with privacy in open offices (Yenel & Demirkan, 2020, p. 310)

Methods	**Instruments**	**Studies (Author/s, Date)**
Qualitative Research	Systematic review process	Meinel et al., 2017
Quantitative Research	Occupant survey questionnaire	Kim & de Dear, 2013
Quantitative Research	Survey questionnaire, measurements of the office characteristics	Laurence et al., 2013
Quantitative Research	Survey questionnaire	Bergstörm et al., 2015
Quantitative Research	Survey questionnaire	Haapakangas et al., 2018
Mixed Methods Research	Post-occupancy survey questionnaire and interviews	Parkin et al., 2011
Mixed Methods Research	Survey questionnaire, work@task	Blok et al., 2012
Mixed Methods Research	Interviews, personal observations, pre- and post-occupancy survey questionnaire, document analysis	Brunia et al., 2016

Laurence et al. (2013) investigated the effect of architectural privacy and workspace personalization on emotional exhaustion at work through a survey questionnaire and measurements of the office characteristics. The experience of privacy and emotional exhaustion were evaluated through the survey questionnaire. The privacy experience was analyzed by combining task privacy and communication privacy items in the survey. Emotional exhaustion is also measured by eight items from the exhaustion sub-scale of the Maslach Burnout Inventory (MBI). Architectural privacy was determined by a binary measure that analyzes whether each employee worked in a traditional office. Workspace personalization is decided by the number of items used to personalize workspaces. Moreover, Bergstörm et al. (2015) also used questionnaires with close-ended questions as an instrument for their research. They created a survey to assess perceptions of the office after transitioning to open-plan offices. Questionnaires were sent to participants before and after relocation to the open-plan office. Survey questions investigated the perception of work and workspace, perceived performance, work capacity, and health indicators. Another study, which used survey questionnaires, aimed to analyze the relationship between office distractions and problems related to these distractions (Haapakangas et al., 2018). It also aimed to evaluate the benefits of quiet workspaces in open-plan offices. Survey data was gathered before and after relocation to open offices. Survey questionnaires with close-ended questions included work demands, mobility, visual privacy, comfort, perception of office spaces, and indoor environment.

Also, some office researchers used mixed methods research as a methodology. Parkin et al. (2011) compared two different academic workspaces regarding

collaboration and privacy by using a post-occupancy survey questionnaire with close-ended questions and interviews as an instrument. Quantitative data was gathered through survey questionnaires that included the general tendency of employees to work in a building, suitability of the building to various work activities, participants' satisfaction with their workspace, and usability of different working areas within the building. Qualitative data is drawn from interviews and comments of questionnaire respondents. Semi-structured interviews were used to form the questionnaire and carried out before the questionnaire. It aimed to define the crucial elements that affected the perceived ability of participants to work efficiently in the building. Blok et al. (2012) investigated how new ways of working have changed work behavior using a web-based internet questionnaire and work@task as an instrument. The questionnaire was conducted twice: before and after applying the New Ways of Working (NWW). It was carried out to analyze NWW knowledge, work behavior alteration, and business consequences. In addition to the questionnaire, a newly developed objective measuring method called work@task was used to monitor changes in work locations such as brainstorming areas and meeting rooms. Moreover, Brunia et al. (2016) used interviews, pre-occupancy and post-occupancy survey questionnaires, document analysis, and personal observations in order to explore which factors explain the percentages of satisfied employees in offices. They compared two cases with high satisfaction and two with low satisfaction values in the same organization. The questionnaire consisted of questions including employee satisfaction with the organization, work content, building layout, privacy, concentration, communication, indoor environment, and remote working. In addition to the survey questionnaire, employees' physical office environment and

behavior were gathered through interviews, personal observation, and document analysis.

In prior office research, questionnaires were commonly employed to gather information about open-plan offices. Nevertheless, responses varied within the same office due to differing workspace placements, leading to varied levels of privacy. To comprehend the fluctuations in responses, a thorough examination of the open office layout is essential. While many studies have concentrated on visual privacy in open-plan offices using traditional methods, there is a shortage of research applying computational approaches to visual privacy and work-process interaction. This thesis employs a mixed methods approach, incorporating space syntax methodology to address this gap.

2.5. Visibility Analysis using Space Syntax Methodology

Space syntax theory was developed by Hillier and Hanson at the University College London (UCL) in the late 1970s to early 1980s as a tool to help urban planners. They published *The Social Logic of Space* in 1984, which mainly focused on syntactic theory for the organization of spaces. In this book, Hillier and Hanson claimed that the spatial properties of buildings and cities are translated into sociological rules (Alitajer & Nojoumi, 2016). Space syntax methodology examines spatial arrangements by assigning values to spaces within an architectural layout based on their social activity level (Aknar & Atun, 2017). This theory posits a correlation between a space's spatial layout and social characteristics, and it defines how spatial

organization influences occupant behavior (Penn, 2005). By analyzing spatial configurations, various social patterns can be defined (Hillier, 2007). Instead of metric distance, space syntax deals with directional changes in spaces.

In space syntax methodology, space is more connected if it can be seen from more spaces or reached from more spaces without directional changes. Space is more visually integrated if it can be seen or reached easily from another space with few changes in sightlines or movement direction (turns) (Lu & Seo, 2015).

Visual privacy negatively correlates with visibility, as heightened visibility leads to diminished visual privacy. Consequently, achieving visual privacy necessitates not being visible (Garvey, 2005). Visibility analysis in the built environment involves examining visibility through two main approaches: generic and targeted visibility analysis. Generic visibility analysis encompasses assessing visibility across all areas visible from any given point within a setting. Conversely, targeted visibility analysis focuses on particular visual objects, determining their visibility from various locations within the setting (Lu et al., 2009). The visibility of specific visual targets – targeted visibility – affects certain cognitive processes and behavior (Lu & Seo, 2015). For instance, in open-plan offices, interactions are affected because of the visibility of other employees moving around (Peponis et al., 2007).

2.5.1. Generic Visibility Analysis

Generic visibility analysis encompasses assessing visibility across all areas visible from any given point within a setting (Lu et al., 2009). UCL DepthMap is utilized to

conduct generic visibility analysis. Specifically designed as a space syntax software, UCL DepthMap describes and assesses spaces to gain insights into social dynamics (Aknar & Atun, 2017).

The software's syntactic analysis comprises these components:

1) Axial line analysis: It is used if elements are linear (Hillier, 2004). A connection graph illustrates how each line connects to its surrounding lines. This analysis is mainly used for cities and villages.
2) Convex space analysis: It concentrates on social interactions when space exhibits non-linear characteristics (Hillier, 2004). It is mainly used for interior spaces of buildings.
3) Visibility graph analysis (including single isovists and isovist fields): It is used when the study subject shows complicated behavior patterns (Hillier, 2004).
4) Agent analysis: Virtual entities known as agents are introduced to the space to determine their movement within it (Hillier, 2004).

The axial analysis is the most used one among these analyses. However, in order to perform architectural analysis, visibility graph analysis is used (Figure 4).

Figure 4. Visibility graph analysis of an open-plan office through DepthMap

During visibility graph analysis, the following tools are widely used:

1) Connectivity: Connectivity measures the number of spaces immediately connecting the space of origin (Hillier & Hanson, 1984).

2) Visual Integration: Visual integration measures the visual distance from all spaces to all others (Hillier, 2007).

3) Step Depth: Step depth follows the shortest part from the selected root line (or segment) to all other lines (or segments) within the system (Turner, 2004).

Moreover, two spatial metrics are used to perform generic visibility analysis in the built environment (Sailer et al., 2021):

- *Degree (n)* indicates the number of people someone is directly connected with. It defines the number of visible people within the 360° isovist area.
- *Density* (n/m^2) indicates the number of people per square meter. Density was calculated by the ratio of the degree to the area of the 360° isovist.

2.5.2. Targeted Visibility Analysis

Besides general visibility analysis, certain research highlights how the visibility of particular objects within the built environment influences various behaviors and cognitive actions (Lu & Seo, 2015). Peponis et al. (2004) suggested that how art pieces are displayed in museums affects how visitors move and experience the exhibits. Similarly, Peponis et al. (2007) found that the visibility of colleagues walking around the workplace promotes employee interactions. Also, the visibility of building elements impacts the wayfinding behaviors of building occupants (Omer & Goldblatt, 2007). The studies above emphasize the importance of particular objects or visual elements within a building, highlighting their greater significance compared to others (Lu & Seo, 2015). On the other hand, analyzing the entire space where objects of interest are located provides clues about the whole space instead of specific targets (Lu & Seo, 2015). Thus, conducting a targeted visibility analysis is essential to assess the visibility of particular elements. Targeted visibility analysis deals with specific visual elements and assesses how many can be seen from various points within a building (Lu et al., 2009).

Visibility is influenced by the likelihood of observing other occupants, the visibility affordance of the space, and the movement patterns of people within the building

(Hadi & Zimring, 2016). Therefore, targeted visibility is based on Gibson's theory (1979) of visual perception, especially his explanation of affordances. According to Gibson (1979), the relationship between humans and the environment is described through the affordances that the environment provides and offers. Particular environmental properties are more important than those provided for each person in a group (Lu & Zimring, 2012). According to Gibson (2014), these environmental properties can be surfaces, objects, or people. First, surfaces may afford different behaviors according to their properties. Horizontal and rigid surfaces like roads offer standing or walking, while horizontal and nonrigid surfaces like the sea cannot afford standing but swimming (Gibson, 2014). On the other hand, vertical and rigid surfaces like walls and partitions can be perceived as obstacles. If there is an opening like doors on these surfaces, people perceive them as doorways, and then these vertical rigid surfaces become no longer obstacles for them. Inclined surfaces may afford climbing. If these surfaces are too high, climbing or walking can be perceived as dangerous. In addition to surfaces, objects around us may afford numerous behaviors (Gibson, 2014). Attached objects cannot be separated without damaging them, while detached objects can be moved. Therefore, some objects in the environment may afford to lift, move, carry, transform, and grasp while others may not. For example, an object affords to grasp according to its physical qualities. If the dimensions of an object seem bigger than the span of the hand, this object cannot afford to grasp. However, according to Gibson (2014), the most complex affordances are provided by people compared to surfaces and objects. Although these affordances, people, are also detached objects as they can move and change their bodies, they differ from ordinary objects because they respond to the behavior. Unlike objects, people interact with other people. In other words, behavior affords

another behavior among people. Therefore, the perception of what other people afford becomes crucial to understand the relationship between humans and the environment (Gibson, 2014). Gibson's theory is twofold (Lu, 2010). First, specific environmental characteristics are more important and more noticeable than others for a person. Therefore, a visibility analysis should deal with specific targets that are more important to its occupants. Second, several environmental properties could be important for different occupants. Thus, visibility analysis should also deal with different environmental properties relevant to different occupants (Lu, 2010). Therefore, alongside generic visibility analysis, the visibility assessment should prioritize specific targets that hold greater significance for building occupants than other environmental factors (Lu & Zimring, 2012). Analysis of specific targets helps to interpret occupants' behavior and perceptions (Lu & Zimring, 2012).

In order to analyze targeted visibility in intensive care units, Lu (2010) developed the targeted visibility analysis through ArcGIS. For targeted visibility analysis, people mainly need to have a floor plan of a selected building and the cell size of a grid (Lu, 2010). In order to perform targeted visibility analysis, a grid of observation points is first replaced on top of a selected floor plan. Then, specific values are given automatically to selected visual targets in order to define them. Following the identification of visual targets, a straight line from the observation point to each visual target is formed. The target is defined as visible if this line does not cross any line in the floor plan. However, if the line connecting the observation point and visual targets crosses other lines in the floor plan, the target is defined as invisible. In addition, Lu (2010) introduced the Targeted Visibility Index (TVI) to differentiate targeted visibility levels among different spaces. TVI is a beneficial tool for

evaluating visibility affordances in buildings. According to Lu (2010, p. 55), TVI is "the ratio of average targeted visibility values of all locations in the setting to the number of preselected targets." TVI changes between 0-1. If TVI is 1, all targets are visible from all locations. If TVI is 0, targets cannot be seen from any place in a given environment (Lu, 2010).

Moreover, two spatial metrics are used to perform targeted visibility analysis in the built environment (Sailer et al., 2021):

- *Outdegree (n)* indicates the number of people directly visible to someone in binocular vision limits. It defines the number of visible people within the 120° forward-facing isovist area.
- *Binocular Density* (n/m^2) indicates the number of people per square meter. Binocular density was calculated by the ratio of the outdegree to the area of the 120° isovist (Sailer et al., 2021).

2.6. Research Gaps of Previous Studies

Previous research on visibility graph analysis has some limitations. First, many studies on visual privacy concentrate solely on general visibility analysis rather than the visibility of particular objects. Secondly, studies focusing on targeted visibility analysis address settings like hospitals and museums. However, targeted visibility analysis in office environments is not extensively studied. Moreover, a study focusing on visual privacy and using a computational approach to analyze it is rare.

Next, very few studies have developed a tool to measure targeted visibility. Lastly, there is a lack of in-depth research on the influence of visual privacy on interactions, particularly within work-process contexts.

In order to address these gaps mentioned above, this thesis investigates how visual privacy impacts work-process interactions using both generic and targeted visibility analyses, along with a computational approach. The following chapter comprises research questions, hypotheses, procedure, settings, participants, instruments, data analysis, and pilot studies.

CHAPTER 3

METHODOLOGY

3.1. Research Questions and Hypotheses

This thesis is designed to address the following questions:

RQ1: How does generic visibility affect work-process interactions?

RQ2: How does targeted visibility affect work-process interactions?

Based on the literature review, degree, density, and visual integration are parameters used to measure generic visibility. Thus, the following hypotheses were formulated to examine how generic visibility affects work-process interactions.

H1: Degree is negatively correlated with the number of work-process interactions.
H2: Density is negatively correlated with the number of work-process interactions.
H3: Visual integration is positively correlated with the number of work-process interactions.

Based on the literature review, outdegree, binocular density, and targeted visibility ratio are parameters used to measure targeted visibility. Therefore, the following

hypotheses were suggested to investigate the effects of targeted visibility on work-process interactions.

H4: Outdegree is negatively correlated with the number of work-process interactions.

H5: Binocular density is negatively correlated with the number of work-process interactions.

H6: Targeted visibility ratio is negatively correlated with the number of work-process interactions.

H6a: Targeted visibility ratio at personal distance (60 cm) is negatively correlated with the number of work-process interactions.

H6b: Targeted visibility ratio at social distance (150 cm) is negatively correlated with the number of work-process interactions.

3.2. Procedure

The study employed qualitative and quantitative research methodologies to explore the research questions, illustrated in Figure 5. The research began by gathering qualitative data to detect patterns of work-process interactions through observation and a survey. The second step of the study was quantitative data collection through visibility graph analysis. DepthMap software was used in order to obtain generic visibility analysis. Then, targeted visibility analysis was performed following the developing of a new script for DepthMap software.

After collecting both qualitative and quantitative data, the study compared the results of these analyses and the survey to explore the impact of targeted and generic visibility on work-process interactions within open-plan offices. In terms of work-process interactions and visual privacy, new design guidelines were proposed for open-plan offices.

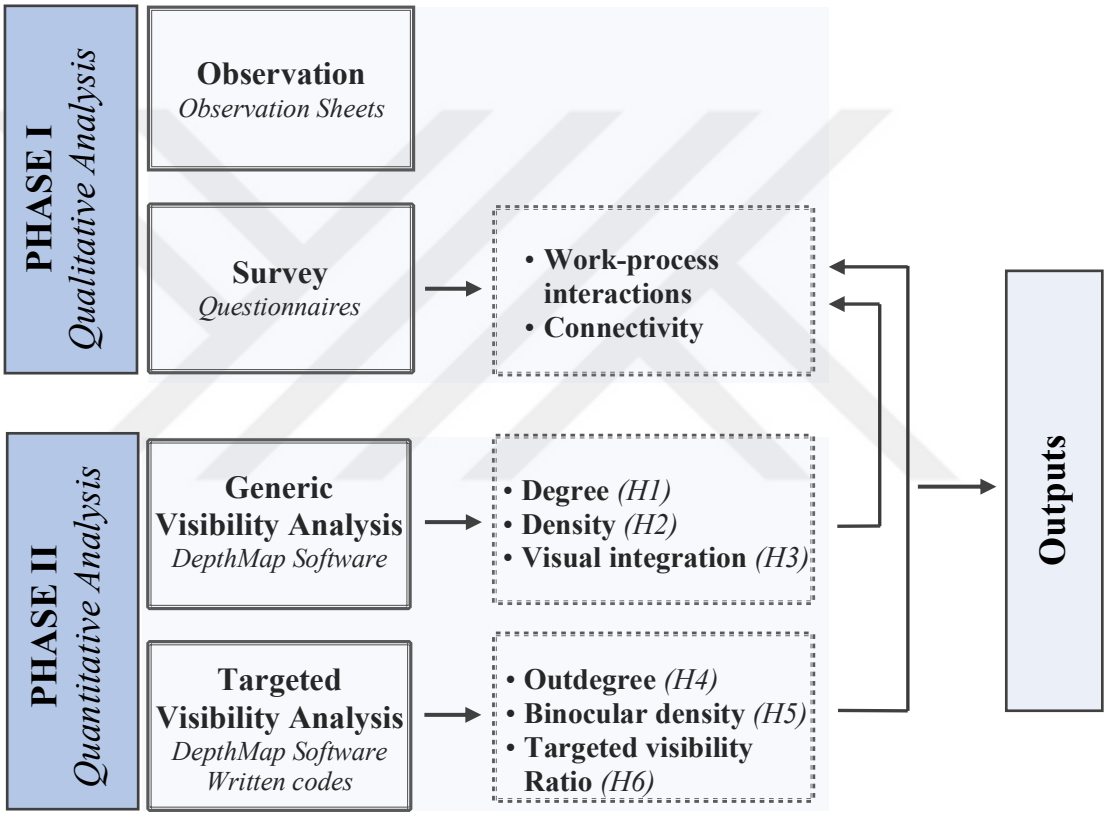


Figure 5. Framework of the study

3.3. Setting

To comprehend how visual privacy impacts interactions during work processes in open-plan offices, the study was conducted in Öncüoğlu Architects and Tepe Home

in Ankara, Turkey. These offices were selected as settings for this study because of their open-plan layout and the work type performed in them. Both offices were architectural design firms. The office building of Öncüoğlu Architects was located in the middle of a residential complex. Thus, it was isolated from the main roads (Figure 6). Moreover, the office building of Tepe Home was located on a university campus and also separated from the main roads (see Figure 7).

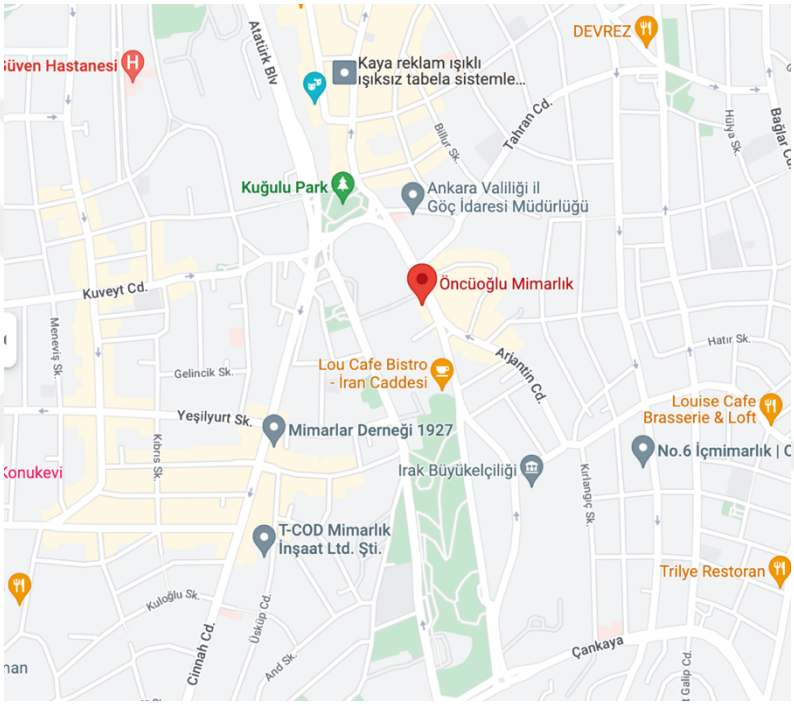


Figure 6. The location of Öncüoğlu Architects (Source: Google Maps, 2022)

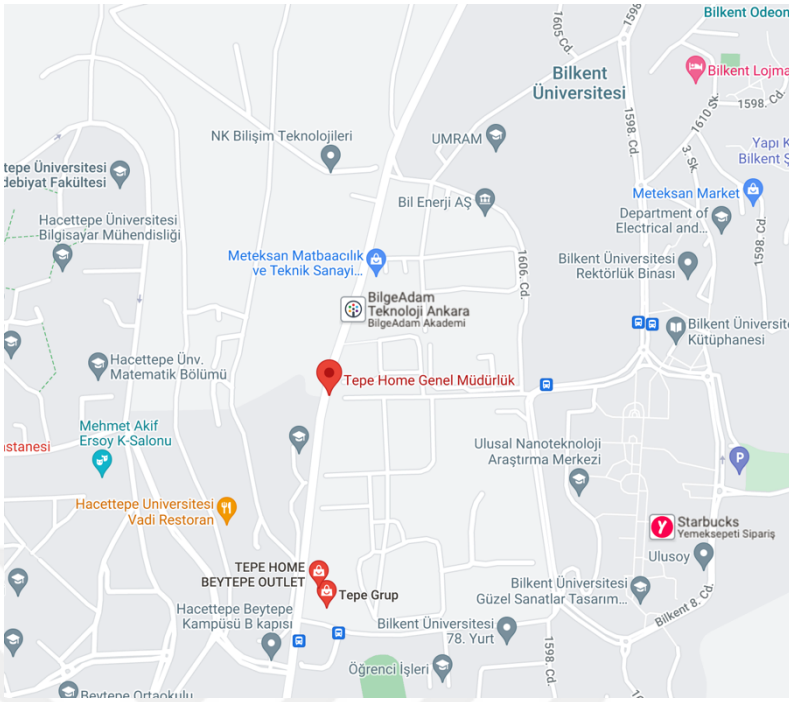


Figure 7. The location of Tepe Home (Source: Google Maps, 2022)

The open-plan office of Öncüoğlu Architects had a 3-story office building in a residential complex. The basement floor had a restaurant, a hobby and model room, an archive, and wet areas. The ground floor had five private offices, a closed meeting space, an open meeting space, and an open office area, as shown in Figure 8. The first floor also had four private offices, a lounge, and an open meeting area for 12 people.

Figure 8. Plan and 3D representation of Öncüoğlu Architects in Ankara

The ground floor of the office building was selected for this study because the open office space was located on this floor. The total ground floor area was 325 m^2, and the open office space was 139.95 m^2. Only two building facades had openings, and the open-plan office had 18 windows. Therefore, almost half of employees had access to natural light and ventilation in their workspaces, while others had limited

access. Moreover, workspaces without openings had a poor visual relationship between indoor and outdoor spaces.

The office building of Tepe Home was located on the campus of Bilkent University. The ground floor of the building belonged to the workshop for furniture production. The first floor had private offices for logistics, law, marketing, purchasing, quality control, and export departments. In addition, this floor had three meeting rooms and administrative offices. Moreover, the open office space was also located on this floor, as shown in Figure 9. The first-floor area was 1194 m^2, and the open office space was 301 m^2. Only one facade of the open office space had openings. Therefore, except for one employee, all other employees did not have access to natural light and ventilation while working in the office. Thus, these employees could not experience the visual relationship between indoor and outdoor.

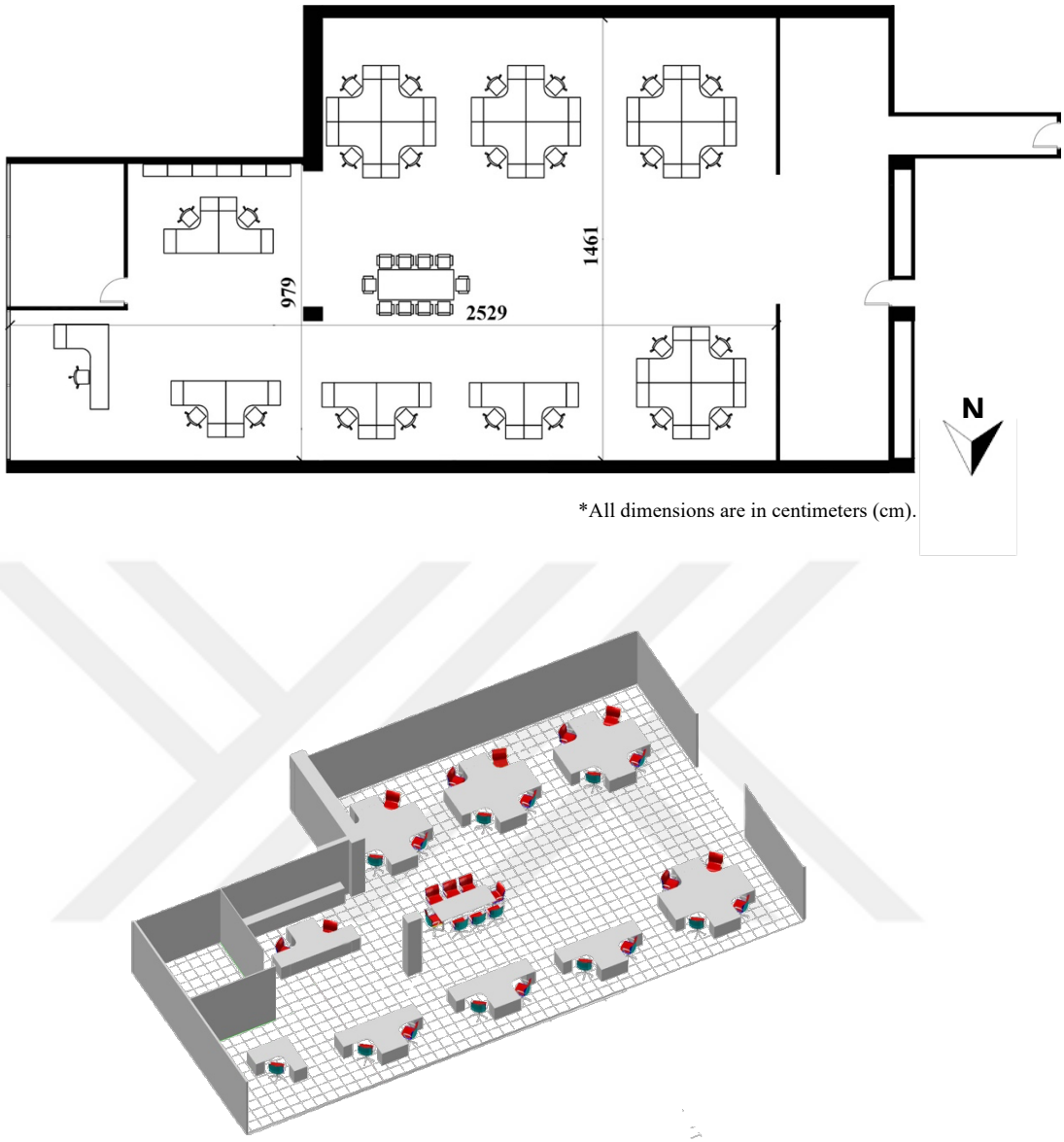


Figure 9. Plan and 3D representation of Tepe Home in Ankara

3.4. Participants

The study was conducted with 30 employees working at Öncüoğlu Architects and Tepe Home in Ankara, Turkey. The participants were chosen from employees whose workstations were in the offices' open-layout section. Workstations in open-plan offices were assigned to employees by administrative employees. Participants were

seated employees facing their computers, and visibility analysis was carried out according to this position of the employees. All participants were non-managerial employees at the same level within the hierarchy. Any personal information about the participants was kept confidential. Participants' identities were hidden, and the participants' names were coded into numbers.

Fifteen employees from Öncüoğlu Architects were voluntarily involved in the study and assigned numbers one through 15, as shown in Figure 10. The survey included employees whose desks were situated in the open-layout area of the office. The sample consisted of 11 female and four male participants. Twelve participants were architects, two were draftsmen, and one was an interior designer. Participants' ages ranged from 22 to 49, with a mean age of 29.27 years (SD=7.28).

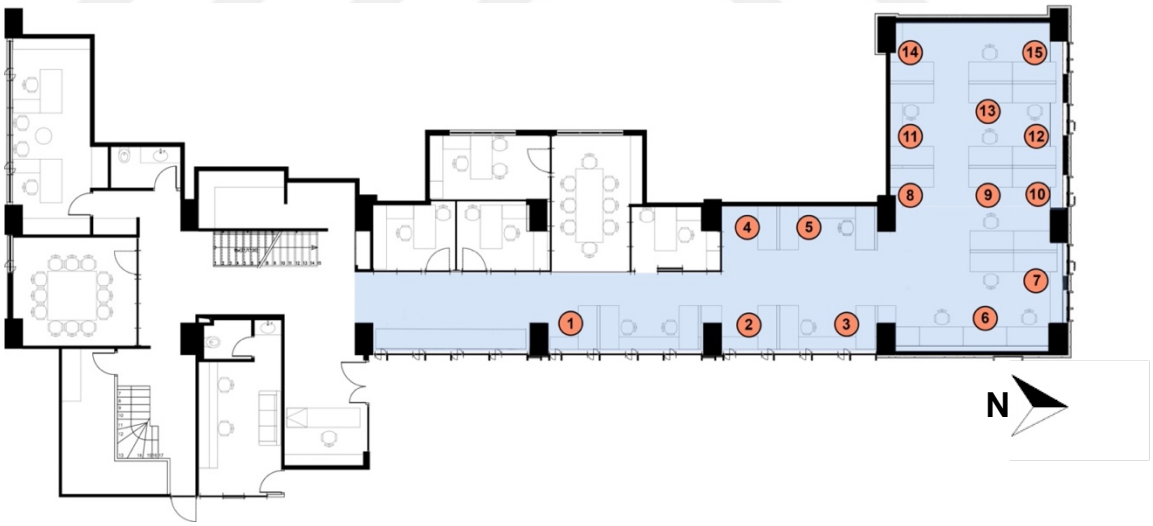


Figure 10. The ground floor plan of Öncüoğlu Architects in Ankara

Fifteen Tepe Home employees were also voluntarily involved in the study and assigned numbers one through 15, as shown in Figure 11. The sample consisted of

five female and 10 male participants. Three participants were working in the engineering department, two in the logistics department, and the other two in the R&D (Research and Development). Moreover, two participants were in the design department, two were in the marketing department, two were in the purchasing department, and two were in the production department. Participants' ages ranged from 22 to 50, with a mean age of 34.73 years (SD=8.15). Employees who participated in the survey were indicated with orange circles. None of the participants from Tepe Home had direct access to windows.

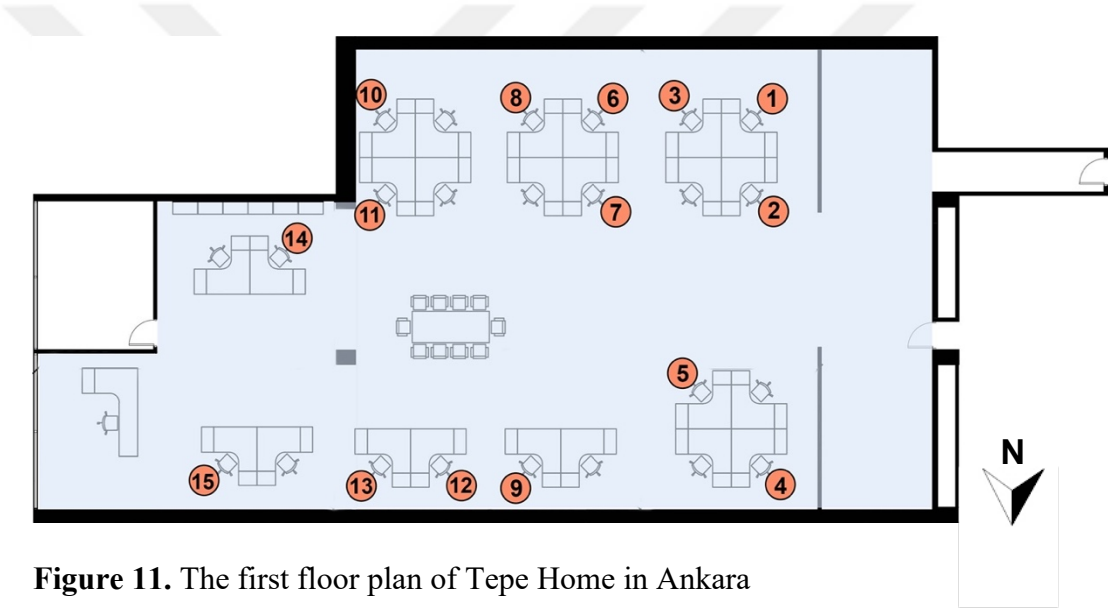


Figure 11. The first floor plan of Tepe Home in Ankara

3.5. Instruments

Four instruments were used in this study. These instruments were (1) observation sheets, (2) a survey, (3) DepthMap Software, and (4) written codes in Python.

3.5.1. Observation Sheet

Observation sheets were the foundation for a survey designed to understand employee interactions in open-plan offices. These sheets provided preliminary insights into employees' interaction behaviors within the natural context of open-plan offices. Observation sheets had two parts. The first part of the observation sheets was prepared to record workspace locations and determine the observation path when employees were not in open-plan offices. The second part of the observation sheet was prepared to obtain information on assigned numbers of desks in which interactions took place, interaction type (work-process interactions/social interactions), and the duration of the interaction (in minutes) (see Appendix A).

3.5.2. Survey

Following the observation sheets, a survey with open-ended and close-ended questions was prepared to obtain more concrete evidence of work-process interactions among employees in two open-plan offices. The study was reviewed and approved by the Ethics Committee of Bilkent University (No:2021_11_23_01) (see Appendix D). The survey consisted of four sections with open-ended questions. The first section of the survey consisted of questions related to demographic data; age, gender, and occupation. The second section of the survey concentrated on employee perceptions of workspaces regarding visual and acoustical privacy, crowding, territoriality and noise. The third section of the survey was designed to identify interactions in open-layout offices. Each workstation on the office floor plans was assigned a number from one to 15 to gather the work-process interactions diagram

(see Figure 11). The survey's first question of the third section requested participants to specify their desk number. On the other hand, the second question asked participants to specify the desk numbers of their colleagues with whom they engaged most frequently for work-related tasks. Following this question, survey participants were asked to define the main reason for interaction with the indicated colleague. The last section of the survey was formed to detect the impacts of the coronavirus pandemic on working conditions, perceptions of workspaces, and interactions with their colleagues in open-plan offices (see Appendices B and C).

The survey consisted of one section with close-ended questions to determine employees' interaction characteristics in the open-plan offices. First, employees were asked to indicate the duration of the interaction and whether it was more than three people. Interactions involving more than three people were classified as group interactions (Weijs-Perree et al., 2020). Employees were also asked to specify if the interaction was planned or unplanned (Hillier et al., 1984). Then, they were asked whether it was social or work process interactions (Peponis et al., 2007). Also, participants were asked to specify the primary reason for the interaction: expert advice, improvement, decision-making, and innovation (Peponis et al., 2007). Next, employees were asked if they and their colleagues with whom they interacted were from the same team (Wohlers & Hertel, 2017) (see Appendices B and C).

3.5.3. DepthMap Software

DepthMap Software was utilized to test generic and targeted visibility quantitatively. Existing commands in DepthMap were used for generic visibility analysis. However,

a new script was developed for DepthMap and used for targeted visibility analysis (see Section 4.7.4).

The analysis of generic visibility was conducted using UCL DepthMap software. This specialized tool in space syntax identifies and assesses spatial configurations to better comprehend social processes within the built environment (Aknar & Atun, 2017). In 1998, Alasdair Turner developed this software at the University College London from the Space Syntax group as DepthMap. It facilitates spatial analyses by employing integration and visibility calculations, generating hundreds of isovists that illustrate the extent of visible space from particular viewpoints (Turner & Penn, 1999). Figures 12 and 13 show that isovists indicate visible areas from a specific point (Aknar & Atun, 2017). The spatial analysis is accomplished by juxtaposing isovist graphs (Figure 12). In architecture and urban planning, DepthMap Software helps to create visibility graph analysis (Alitajer & Nojoumi, 2016).

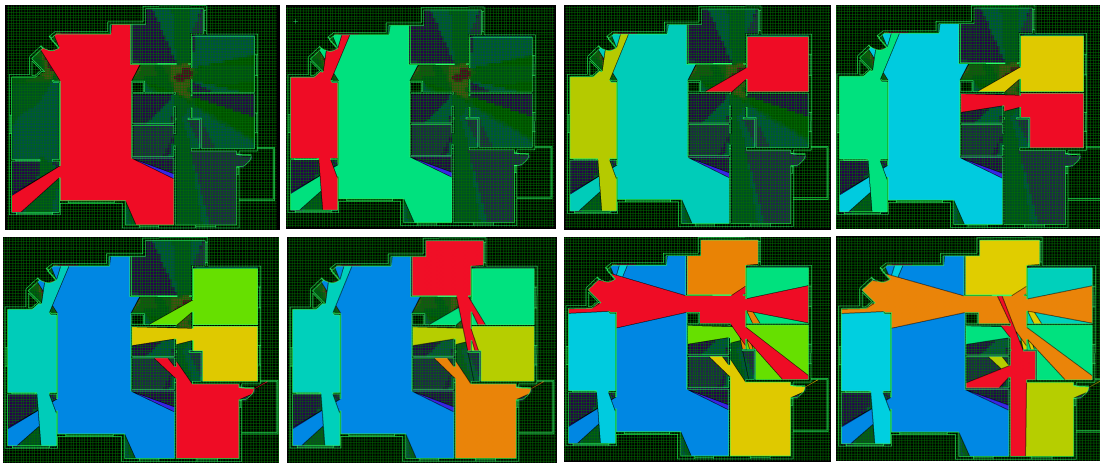


Figure 12. The juxtaposition of isovist graphs, DepthMap software

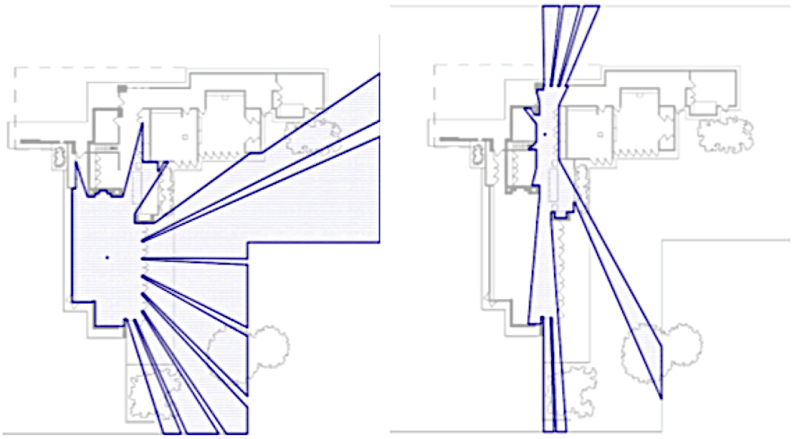


Figure 13. Representation of the isovists in an architectural plan (Frank Lloyd Wright's Jacobs House) (Aknar & Atun, 2017)

3.5.4. Written Codes in Python

In order to develop a plug-in for targeted visibility, codes were written in Python using PyCharm, an integrated development environment (IDE) used in computer programming, specifically for the Python language (see Appendix E). Figure 14 shows preliminary codes written for the first part (Part I – partial isovist analysis) of the proposed targeted visibility analysis. These codes enabled users to demonstrate isovist analysis for selected points on the plan.

```
In [3]: # Uncomment the next lines and run them to generate a text file with the cli options
        # with open("depthmapXcli_commands.txt", "w") as text_file:
        #     text_file.write(subprocess.check_output([depthmapXcli, "-h"]).decode("utf-8"))

In [4]: # Create two isovists in the gallery_connected.graph file and write a new file called
        # out.graph which contains the results. The -ii parameter defines the isovists with 4
        # numbers: x, y, angle, viewangle. The last two values angle and viewangle define the
        # viewing direction and field of view respectively, both in degrees
        subprocess.check_output([depthmapXcli,
                                 "-f",  "data/gallery_connected.graph",
                                 "-o",  "data/out.graph",
                                 "-m",  "ISOVIST",
                                 "-ii", "2.75, 6.80, 320, 90",
                                 "-ii", "4.95, 6.55, 150, 90"])

Out[4]: b'Loading graph data/gallery_connected.graph ok\nMaking 2 isovists...  ok\nWriting out result... ok\n'

In [5]: # Convert the isovists to a convex map (can't export data-maps yet)
        subprocess.check_output([depthmapXcli,
                                 "-f",   "data/out.graph",
                                 "-o",   "data/out.graph",
                                 "-m",   "MAPCONVERT",
                                 "-co",  "convex",
                                 "-con", "tempconvex"]);

In [6]: # Export the isovists from out.graph into a mif/mid pair called 'out.mif'
        # and 'out.mid' and erase the former out.graph file
        subprocess.check_output([depthmapXcli,
                                 "-f",  "data/out.graph",
                                 "-o",  "data/out.mif",
                                 "-m",  "EXPORT",
                                 "-em", "shapegraph-map-mif"]);
        os.remove("data/out.graph")

In [7]: # read the mif file into a variable
        isovists = geopandas.read_file("data/out.mif")
        # set the CRS to avoid having geopandas complain
        isovists.crs = ''
        # delete the mif/mid files
        os.remove("data/out.mif")
        os.remove("data/out.mid")

In [8]: # to make visualisation easier load the gallery plan (from a shapefile) for later plotting
        galleryPlan = geopandas.read_file("data/gallery-plan.shp")
        galleryPlan.crs = ''

In [9]: # quick plot to see the outcome of the above (should be two isovists)
        fig, ax = plt.subplots(figsize=(20, 10))
        ax.axis('off')
        ax.set_aspect('equal')
        galleryPlan.plot(ax=ax, edgecolor='black')
        isovists.plot(ax=ax, edgecolor='black')
```

Figure 14. Written codes for the proposed targeted visibility (Part I)

Figure 15 shows preliminary codes for the second part (Part II – computing the total count of grids within the selected isovist area) of the proposed targeted visibility analysis. These codes enabled users to calculate the total count of grids within the selected isovist area.

```
insidePoint=0;

with open('file_name.csv', 'r') as read_obj:
    csv_reader = reader(read_obj)
    header = next(csv_reader)
    if header != None:
        for row in csv_reader:
            if row.__contains__("True"):
                insidePoint= insidePoint + 1

gridArea= gridSize*gridSize
gridNumber=visibilityArea2/gridArea
print(insidePoint,"agent can be seen from the view of client")
gizemConstant=gridNumber/insidePoint
print(gridNumber,"is grid number")
print(gizemConstant,"is gizemConstant")
gA=str(gridArea)
iPo=str(insidePoint)
gN=str(gridNumber)
gCns=str(gizemConstant)
```

Figure 15. Written codes for the proposed targeted visibility (Part II)

Figure 16 shows preliminary codes written for the third part (Part III – agent analysis) of the proposed targeted visibility analysis. These codes enabled users to perform agent analysis. Therefore, a graph indicating visible employees in the isovist area was obtained when codes of Part I, II, and III were combined.

```
In [12]: # plot the isovists and the points on top, coloured according to which isovist they are in
         fig, ax = plt.subplots(figsize=(20, 10))
         ax.axis('off')
         ax.set_aspect('equal')
         isovists.plot(ax=ax, edgecolor='black')
         gallery_points.plot(ax=ax, edgecolor='black', column='which_isovist', markersize = 50)
Out[12]: <AxesSubplot:>
```

Figure 16. Written codes for the proposed targeted visibility (Part III)

3.6. Data Analysis

Data collection involved qualitative and quantitative methods. Qualitative methods included observation and surveys, whereas quantitative methods encompassed generic and targeted visibility analyses.

3.6.1. Qualitative Data Collection

The observational phase began by studying the chosen open-plan offices for a preliminary understanding of interactions in them. The observation procedure had two phases. The first phase of the observation was conducted while employees were not in offices. The location of desks and placements of visual barriers (walls and partitions) were recorded and transferred into the ground floor plan to determine the observation location before the second phase. Following the first phase, the second phase of the observation was conducted while employees worked in the open-plan offices during working hours. The observation process took half a day for each open-plan office. To avoid distracting employees during observation, a fixed observation point where each workstation in offices was visible was selected. During the second phase of the observation process, the observer recorded the interaction (location/type) while standing at the pre-defined location in the open-plan offices. Observation sheets (see Appendix A) were used as a base to form the survey (see Appendices B and C). After the observation process, the survey was distributed to the employees in the open-plan part of the selected offices.

3.6.2 Quantitative Data Collection

Quantitative data was acquired via analyses of generic and targeted visibility.

3.6.2.1. Generic Visibility Analysis

Quantitative data collection started by analyzing generic visibility. The DepthMap software served as the tool for this phase of the thesis. It provided metrics such as connectivity, visual integration, degree, and density, which were used to analyze visual privacy within open-plan offices. The visual integration tool was employed to ascertain visual privacy levels. Following a comprehensive visibility analysis, color spectrum maps depicting visual integration, degree, and density across the open-plan office were generated for the comparative phase of the methodology.

3.6.2.2. Targeted Visibility Analysis (TVA)

Following generic visibility analysis, the number of desks visible to someone within the 120° forward-facing isovist (outdegree) and the ratio of outdegree to the area of the 120° isovist (binocular density) were calculated. The Targeted Visibility Analysis Tool (TAVAT) was employed to assess the visibility of specific visual elements, such as other employees walking and sitting, from each workspace within open-plan offices. DepthMap software was utilized to conduct targeted visibility analysis. A Python script for the DepthMap software (TAVAT) was newly developed, utilizing

isovists to calculate visible areas from specific points. Close phases of Hall's interpersonal distances (social and personal zones) were chosen for targeted visibility measurements (Hall, 1969). Therefore, social distance (150 cm) and personal distance (60 cm) were taken into consideration in order to understand if different distances affect targeted visibility values (Hall, 1969).

PART I - It was essential to define specific targets to conduct targeted visibility analysis. In this study, specific targets were other employees walking around and sitting. Then, which employees were visible from each workspace in open-plan offices was decided. Therefore, for each workspace in open-plan offices, isovist analysis was carried out individually, and visible areas for each workspace were defined (Figures 17a and 17b). During partial isovist analysis, calculations of isovists were performed while employees were facing their computers, and only isovists in a binocular vision limit (120°) were taken into consideration (Diffrient et al., 1981).

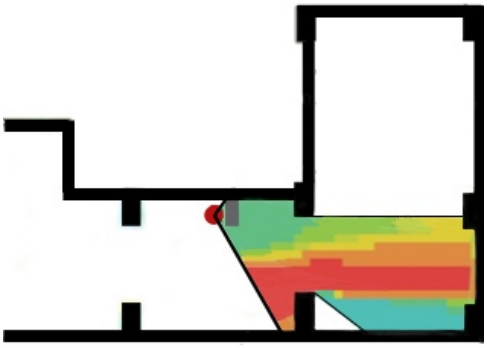


Figure 17a. TVA – Part I

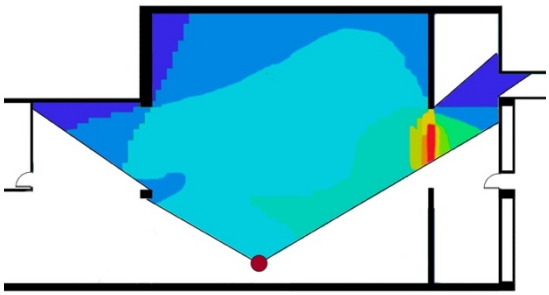


Figure 17b. TVA – Part I

PART II - Following isovist analysis, the total number of grids in the selected isovist area was computed (Figures 18a and 18b). To begin with, the default grid size was used.

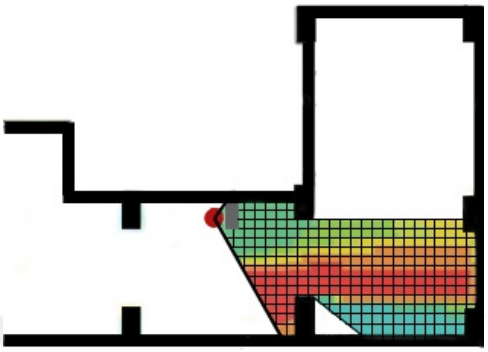


Figure 18a. TVA – Part II

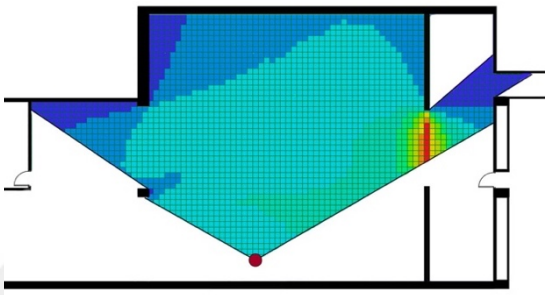


Figure 18b. TVA – Part II

PART III - The number of visible employees for the selected isovist area was determined according to the distance between employees (60 cm or 150 cm). After the distance was determined, virtual people were released into the defined isovist area (Figures 19a and 19b). These virtual people represented other employees who sat, worked, and walked around inside the isovist area.

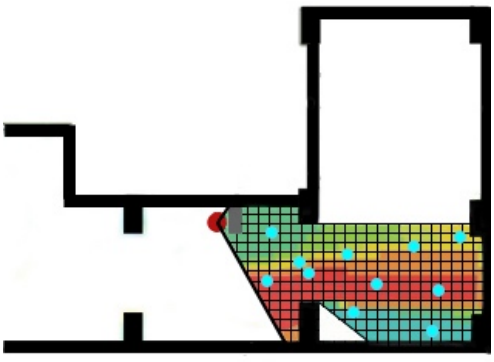


Figure 19a. TVA – Part III

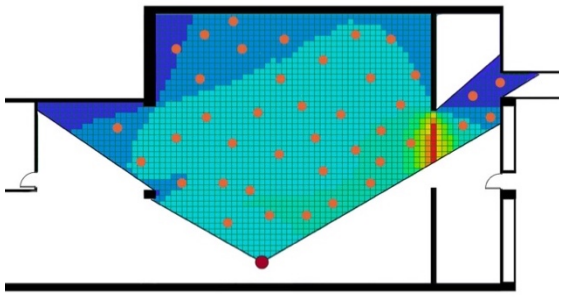


Figure 19b. TVA – Part III

Targeted visibility analysis was calculated by the ratio of the number of visible employees in the isovist area to the number of grids in that area. Following targeted visibility analysis, the targeted visibility ratio of each workspace and maps of the color spectrum for each workspace in the open-plan offices were obtained for the comparisons part of the methodology.

When written codes in Python are run by using PyCharm, the window in order to perform targeted visibility analysis appeared (see Figure 20):

1. A file with an extension of .graph was selected, and the location of this file was entered into the first box.
2. The location of the same file with an extension of .shp was entered into the second box. Graph and Shape files helped juxtapose the open-plan office's blank floor plan with the targeted visibility analysis diagram.
3. A workspace was selected on the floor plan in order to analyze targeted visibility. Values of X and Y coordinates of the chosen workspace were obtained from DepthMapX and transferred into boxes. Values of X and Y coordinates of the selected workspace were necessary for the partial isovist analysis.
4. In order to perform agent analysis for the defined isovist area, the X and Y coordinates of the area for distributed agents were entered.
5. The desired number of agents for the X and Y coordinates were entered into the boxes, the desired distance between agents was determined.
6. The isovist area was obtained from DepthMapX, and the default grid size was entered.

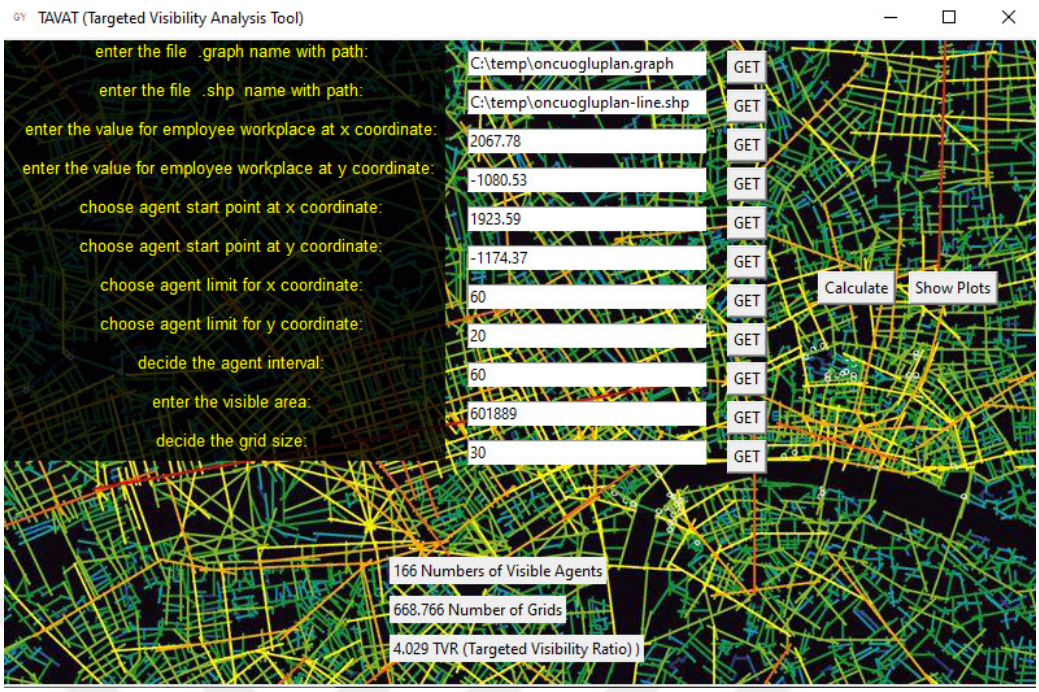


Figure 20. The window to perform targeted visibility analysis

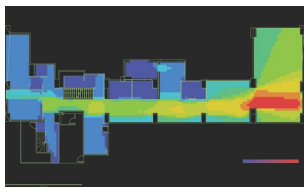
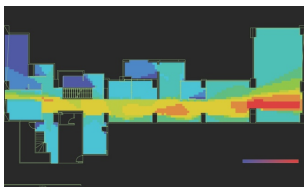
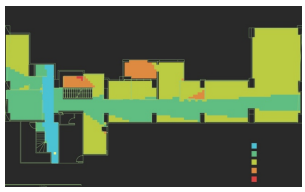
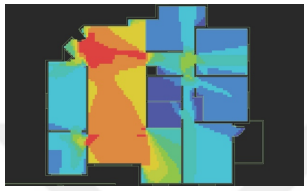
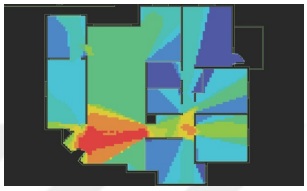
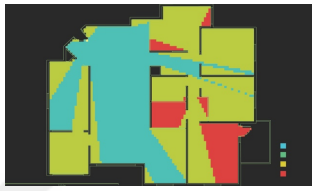
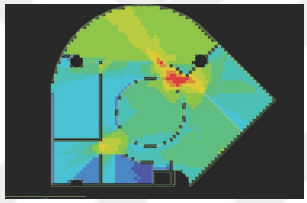
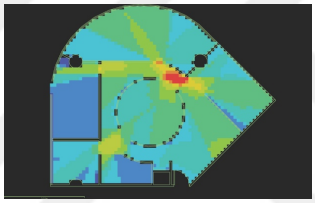
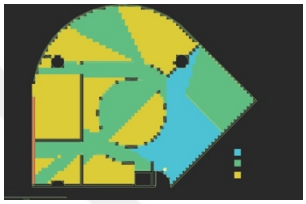
After all necessary data was entered, targeted visibility analysis was determined by dividing the number of visible employees in the isovist area by the number of grids within that area (see Appendix F). Following targeted visibility calculations, maps that represented the targeted visibility ratio were obtained. Collected data through targeted visibility and generic visibility analyses were analyzed qualitatively and quantitatively.

3.7. Pilot Studies

The first pilot study was conducted to perform a generic visibility analysis by DepthMap Software. Three different open-plan offices in Ankara were selected for generic visibility analysis. Open-plan office A was located in an apartment, while

open-plan office B was a villa office. Office C was located in a building complex containing houses, offices, and a shopping mall. The pilot study was conducted in order to understand whether different office locations resulted in different general visibility levels. Each office's connectivity, visual integration, and step depth levels were calculated. Maps of the color spectrum were compared qualitatively through color evaluations from blue to red. Then, these results were compared with each other to realize the differences among different types of open-plan offices (see Table 4). As a result of this pilot study, it was understood that differences among the three office types originated from the shape of the floor plans (rectangular, square, and circular floor plan) rather than the different locations of open-plan offices (apartment, villa, and building complex).

Table 4. Visibility analysis of three different open-plan offices

Office Name	Connectivity	Visual Integration	Step Depth
Office A			
Office B			
Office C			

The second pilot study was conducted to test the written codes in Python for targeted visibility analysis. The first part of the proposed methodology (Part I) was developed to perform partial isovist analysis for a selected point in the plan. Written codes for Part I of targeted visibility analysis were run. The outputs of these written codes are represented in Figure 21. The blue areas indicated the partial isovist areas for two defined points in the plan.

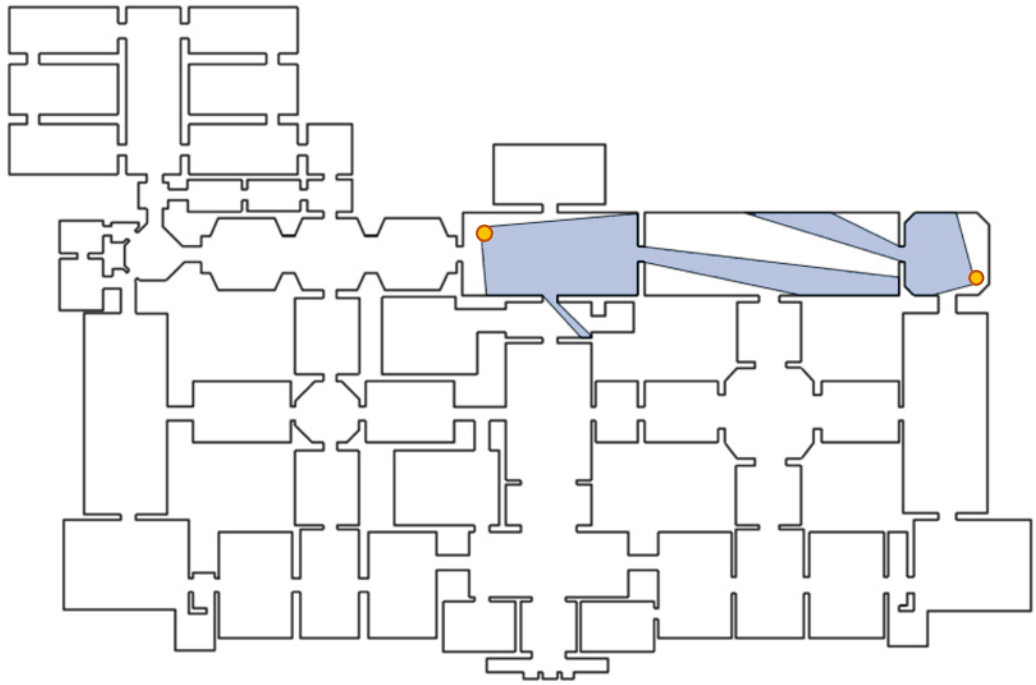


Figure 21. The first output of the written codes for Part I

The third part of the proposed methodology (Part III) was developed to perform agent analysis for partial isovist areas defined during Part I. Codes written for Part III of targeted visibility analysis were run. The outputs of these written codes are represented in Figure 22. Points on blue areas on the map demonstrated virtual people (agents).

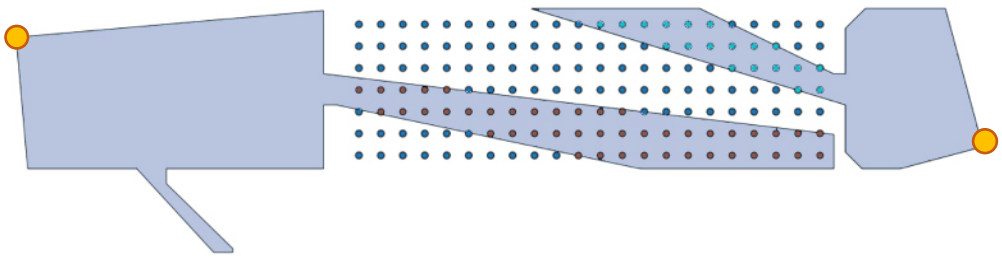


Figure 22. The first output of the written codes for Part III

Another pilot study was conducted to test the final version of the written codes in Python for targeted visibility analysis. Written codes for Part I-II-III were run by using PyCharm. Outputs were obtained as maps (Figure 23) and numerical values (Figure 24) as a result of the proposed targeted visibility analysis.

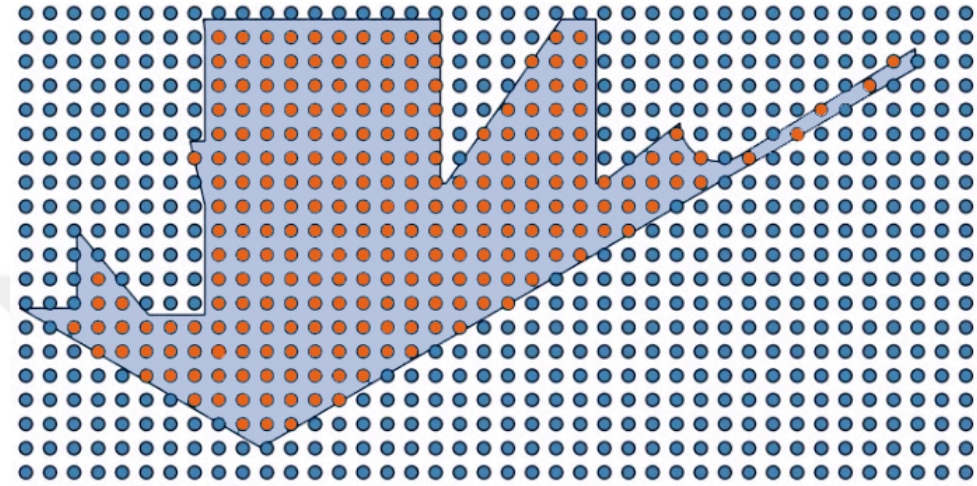


Figure 23. The final output of the written codes for Part I-II-III

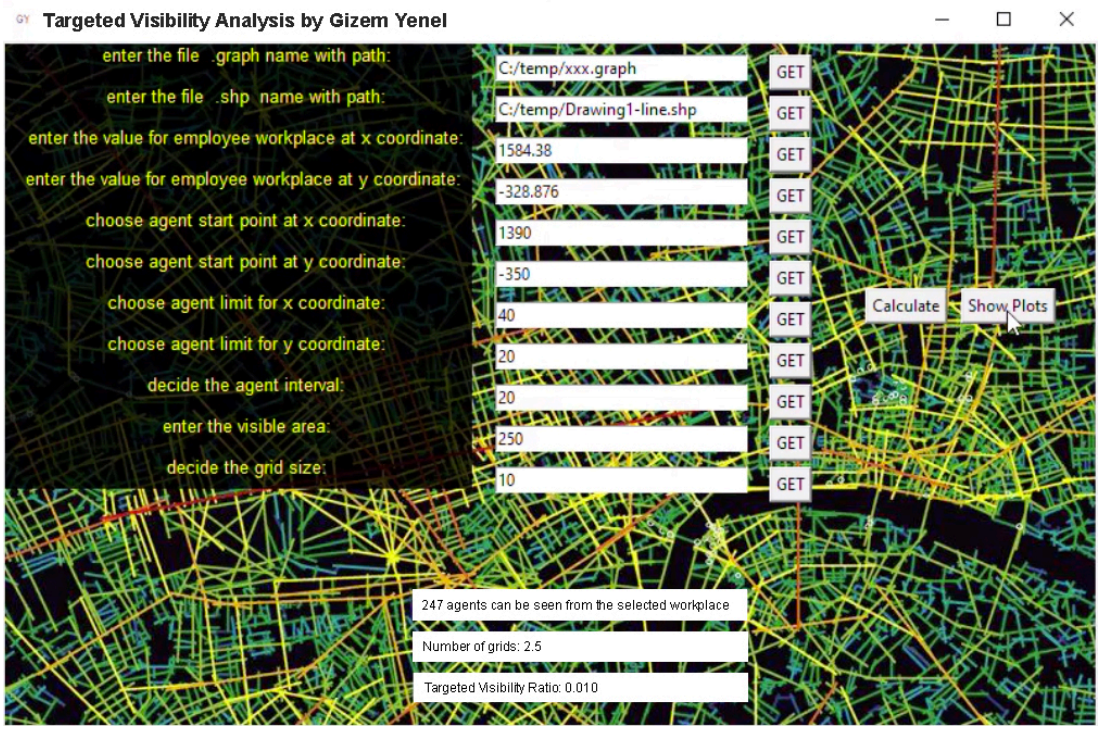


Figure 24. The final output of the written codes for Part I-II-III

After written codes for targeted visibility were tested, two workspaces were randomly selected in order to perform targeted visibility analysis for the study setting. For the first workspace indicated with a red circle, a colored map that showed the partial isovist area and visible employees from the selected workspace was obtained (Figure 25). In addition to the map, the count of visible employees within the specified isovist area was determined (Figure 26). Twenty-six employees were visible from the selected workspace, and its targeted visibility ratio was 7.727.

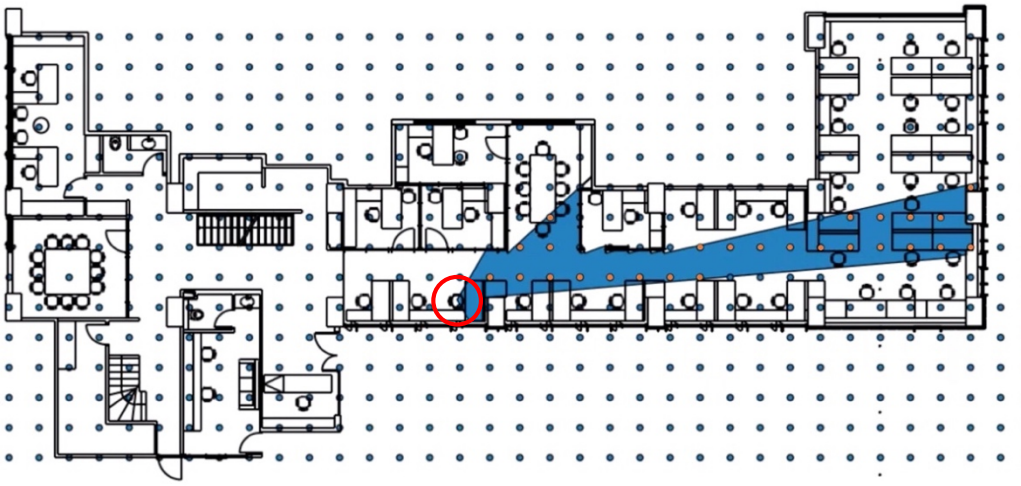


Figure 25. A colored map of targeted visibility analysis for the selected workspace I

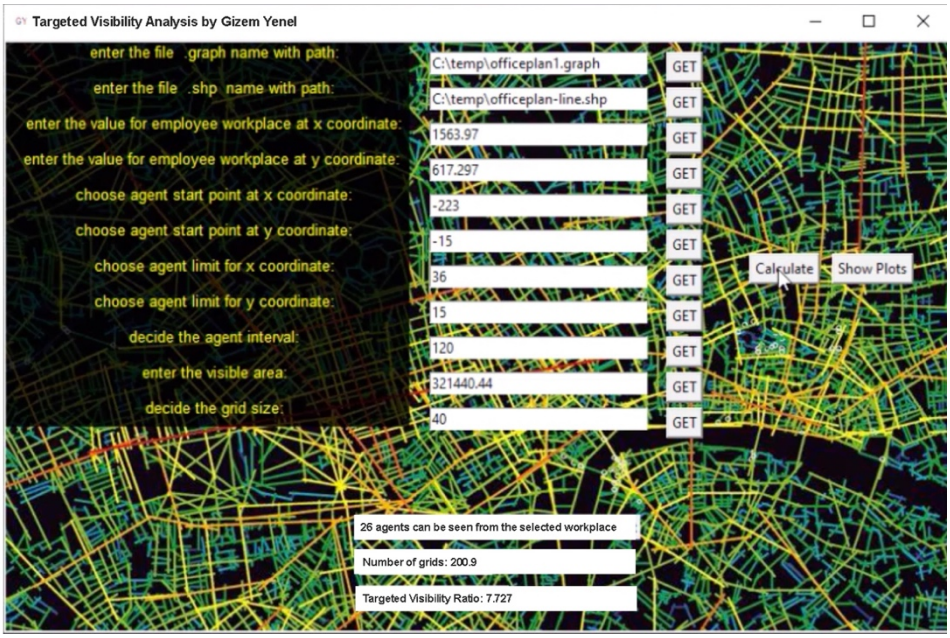


Figure 26. Targeted visibility calculations for the selected workspace I

For another workspace indicated with a red circle, also a colored map that showed the partial isovist area and visible employees from the selected workspace was obtained (Figure 27). In addition to the map, the count of visible employees within the specified isovist was calculated (Figure 28). Thirty-eight employees were visible from the selected workspace, and its targeted visibility ratio was 8.858.

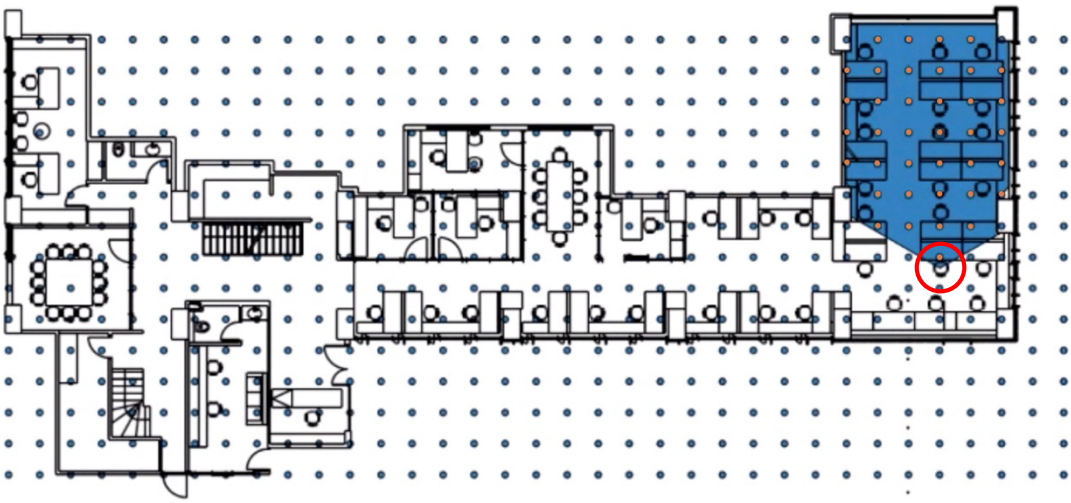


Figure 27. A colored map of targeted visibility analysis for the selected workspace II

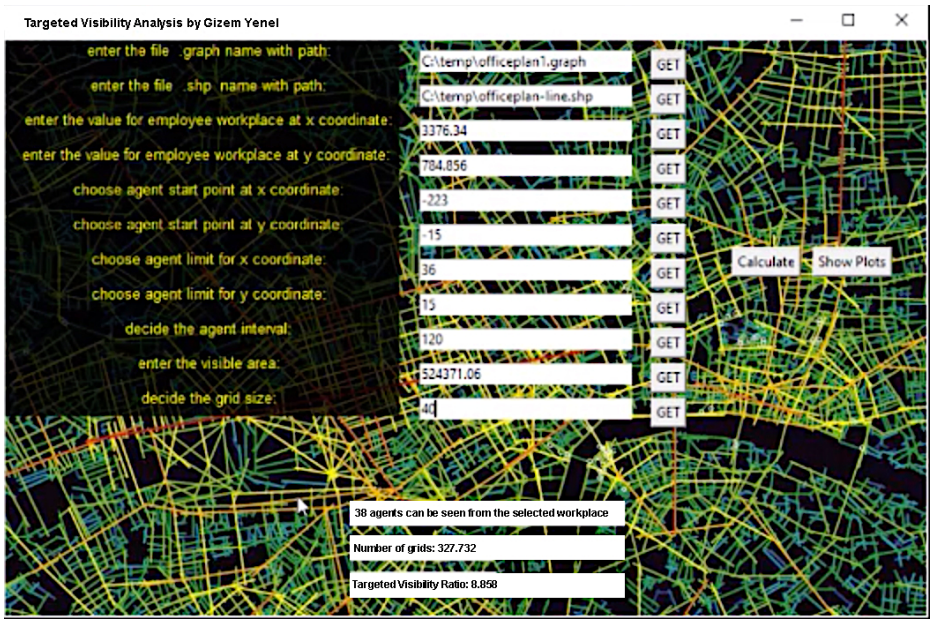


Figure 28. Targeted visibility calculations for the selected workspace II

In the next chapter, the results of the study are presented. The results of the first phase, which analyses the findings of the two open-plan offices qualitatively through a survey and observation, are presented in the qualitative findings section of the next chapter. Then, the results of the second phase, quantitative analysis through generic and targeted visibility analyses, are presented.

CHAPTER 4

RESULTS

The results of the study were analyzed both qualitatively and quantitatively. The data collected through observation and open-ended questions of the survey were analyzed qualitatively while the data obtained from generic visibility analysis, targeted visibility analysis, and multiple-choice test questions of the survey were analyzed quantitatively.

4.1. Qualitative Findings

Qualitative data was gathered through observation and open-ended questions in the survey. Collected data was recorded and coded in order to make inferences from qualitative findings.

4.1.1. Results of Öncüoğlu Architects

Qualitative findings for Öncüoğlu Architects were gathered and analyzed.

4.1.1.1. Observation

The whole observation process in Öncüoğlu Architects took half a day. During the first phase of the observation process, the location of workspaces and placement of partitions in the open-plan office were observed and recorded while employees were not in the office. The locations of desks were drawn on the floor plan (see Figure 29). Although there were partitions in front of employees, there were no partitions on the right and left. In other words, visual barriers decreased the visibility of employees who sat across from each other. However, there was a lack of visual privacy between employees sitting side by side. On the other hand, as partitions were about 130 cm in height, they did not provide acoustical privacy.

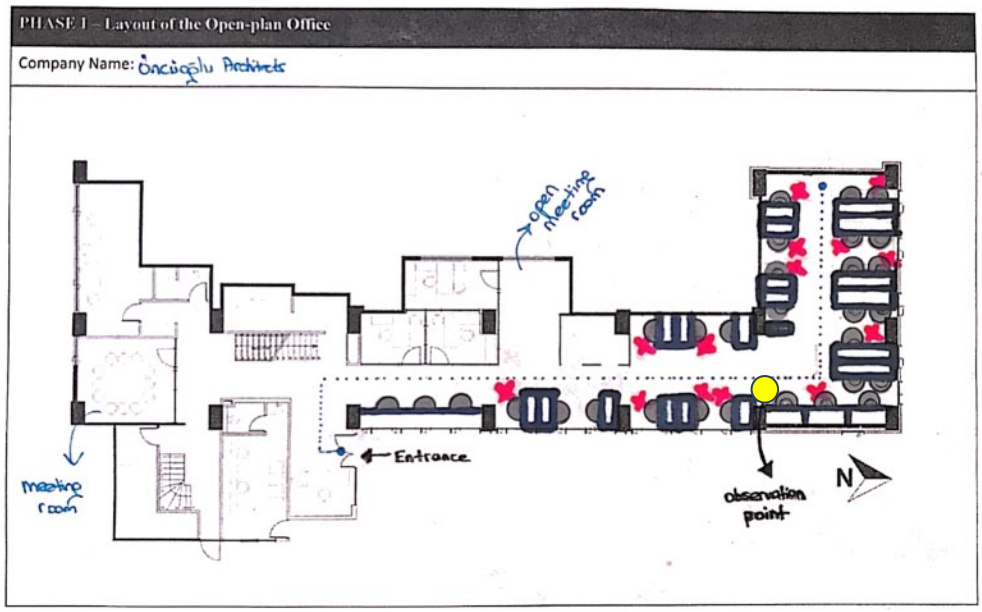


Figure 29. Observation sheet for Öncüoğlu Architects

Following the first phase of the observation, the second phase was conducted while employees worked in the open-open office. Types of interactions (work-process interaction / social interaction) and locations (number of workstations) were recorded

during the second phase. The outcomes of the observation process were identified qualitatively, and field notes were coded according to actions and settings. According to the results of the second part of the observation, there were 15 employees in the office during the observation. The observer's point is shown on the plan with a yellow dot. While standing at the observation point, locations and types of interactions were recorded. The observation began at 14.45 and finished at 16.45. Administrators of the company offered this time slot because it was the time most employees worked in the office.

At the beginning of the observation (14.45), employees at desks 12 and 15 interacted with each other for the work processes, and the duration of this interaction was five minutes. The other 12 employees were working individually. Then, employees at desks 13 and 14 started interacting for work-process at 15.20. The duration of this interaction was about 10 minutes. An employee at desk 12 joined them. These three employees interacted for five minutes more for work processes and social purposes. During this interaction, the remaining 11 employees worked individually. At 16.00, four employees at desks 10, 13, 14, and 15 went outside for a break. They interacted socially for 15 minutes in the office while the other ten employees were working inside the open-plan office. During the second phase of the observation, it was observed that employees who sat close to each other interacted more for both work processes and social purposes.

4.1.1.2. Survey

As previously mentioned, a survey on employee perceptions of workspaces and interactions was distributed to employees following the observation process. At the end of the survey, open-ended questions were analyzed qualitatively. For the first part of the survey, answers to questions related to employee perceptions of workspaces were coded and grouped into six categories: (1) visual privacy, (2) acoustical privacy, (3) noise, (4) distraction, (5) crowding and (6) personal space and territoriality (see Figure 30).

Considering ***visual privacy,*** nine out of 15 employees stated that they had problems in their offices.

> "Partitions are insufficient to provide visual privacy in the open-plan office." *(Employee 1, Male, 39)*
>
> "As I sit near the walkways, I feel that I have poor visual privacy because of the location of their workspaces." *(Employee 2, Male, 30)*
>
> "I feel under pressure in the open-plan office when I cannot complete work on time." *(Employee 10, Female, 28)*
>
> "My colleagues who sit far away from walkways had more visual privacy." *(Employee 12, Female, 27)*
>
> "Other employees could easily see my computer screen because of inadequate enclosure, which makes me uncomfortable." *(Employee 13, Male, 23)*

The other six employees evaluated their workspaces positively according to visual privacy.

> "Working in an open-plan office makes it easier to interact and communicate with my colleagues." *(Employee 3, Female, 23)*

> "I am satisfied with my workspace in terms of visual privacy because my workstation is far away from the corridors." *(Employee 4, Female, 33)*

Considering ***acoustical privacy***, 10 out of 15 employees stated that they felt uncomfortable.

> "I feel my acoustical privacy decreases as I sit close to the walkways." (*Employee 2, Male, 30)*

> "I must go outside for personal calls as I feel my conversation can be heard." *(Employee 12, Female, 27)*

> "There is no boundary in our office to provide acoustical privacy." *(Employee 14, Male, 49)*

Five out of 15 employees were satisfied with acoustical privacy in the open-plan office.

> "I am satisfied with acoustical privacy in our office when I use my headphones or earphones." *(Employee 7, Female, 25)*

Considering ***noise***, four out of 15 participants mentioned that they were uncomfortable with background noise in the open-plan office.

> "I cannot concentrate on the task while working in the noisy open-plan office." *(Employee 4, Female, 33)*
>
> "It is necessary to use earphones when background noise increases in the office." *(Employee 5, Female, 35)*
>
> "Noise becomes annoying when I have a heavy workload in the open-plan office." *(Employee 10, Female, 28)*
>
> "I need to warn my colleagues who make a noise." *(Employee 14, Male, 49)*

Three out of 15 employees stated that noise in their office became annoying if they had a heavy workload in the open-plan office. Otherwise, they were satisfied with their workspaces in terms of noise.

Eight out of 15 employees stated they were not distracted from overhearing other employees' conversations.

> "I am happy with my workspace as I find my solution to the background noise by using earphones." *(Employee 7, Female, 25)*
>
> "I prefer to go outside for social interactions to solve the noise problem in our offices." *(Employee 8, Female, 23)*
>
> "This is not a problem for me to concentrate on my work because I prefer a noisy office environment rather than a quiet one to boost my motivation." *(Employee 13, Male, 23)*

Considering ***distraction***, eight out of 15 employees stated that they were not distracted from their work in the open-plan office.

"I am not distracted from my work in the open-plan office when I fully concentrate." *(Employee 7, Female, 25)*

Seven out of 15 employees mentioned that they lost their attention to the work task in the open-plan office.

"Distractions frequently occur in the office and took place more toward the end of the day." *(Employee 3, Female, 23)*

"I am distracted from my work once an hour." *(Employee 10, Female, 28)*

Considering ***crowding***, eight out of 15 employees stated that the increasing number of employees around their workstations did not affect them negatively.

"Partitions between workstations prevent me from experiencing crowds in the open-plan office. It would be uncomfortable if we do not have partitions in the open-plan office when the number of colleagues around me increases." *(Employee 4, Female, 33)*

"The increasing number of employees boosts my motivation." *(Employee 9, Female, 26)*

Seven out of 15 employees mentioned that they felt uncomfortable when the number of employees around them increased.

"I cannot focus on the task because seeing my colleagues affect me negatively. Therefore, I have to leave my workstation for a while when I have a chance." *(Employee 1, Male, 39)*

"The increasing number of employees means more noise and less visual privacy." *(Employee 5, Female, 35)*

> "I feel there is not enough space to work when I experience crowding in the office." *(Employee 11, Female, 28)*

Considering ***personal space and territoriality***, 11 out of 15 employees mentioned feeling uncomfortable, nervous, and insecure when they lost control over their workspace.

> "I cannot concentrate when I have inadequate personal space in the office." *(Employee 4, Female, 33)*

> "Having control over my workstation is one of the most important factors for my productivity." *(Employee 6, Female, 22)*

> *"*The extensive use of my personal computer by other colleagues in the office makes me nervous. Then, I develop territorial behaviors around my workspace." *(Employee 8, Female, 23)*

Four out of 15 employees expressed that losing control over personal workspaces did not affect them negatively.

> "I am not trying to control my workspace." *(Employee 2, Male, 30)*

> "I maintain my personal space in the open-plan office." *(Employee 9, Female, 26)*

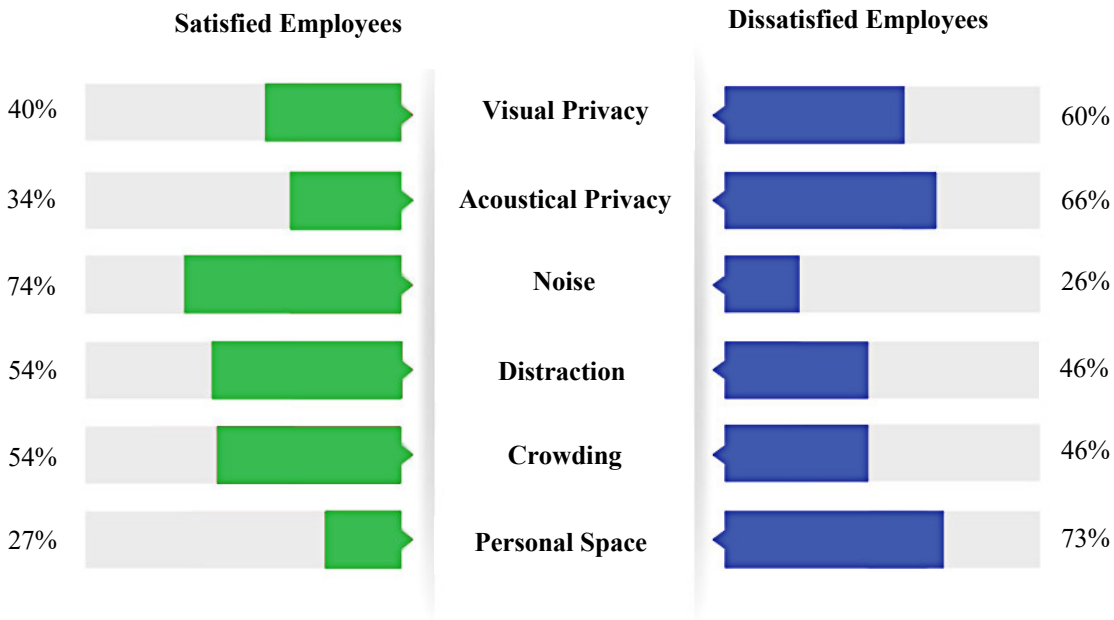


Figure 30. Summary of survey results for Öncüoğlu Architects

The second part of the survey was formed to identify work-process interactions in the office. According to employees' answers, lines connecting the workstation of respondents to their colleagues with whom they interacted the most were drawn. A diagram illustrating employees' work-process interaction patterns was generated (Figure 31). When lines become denser in an area on the plan, they demonstrate higher work-process interactions.

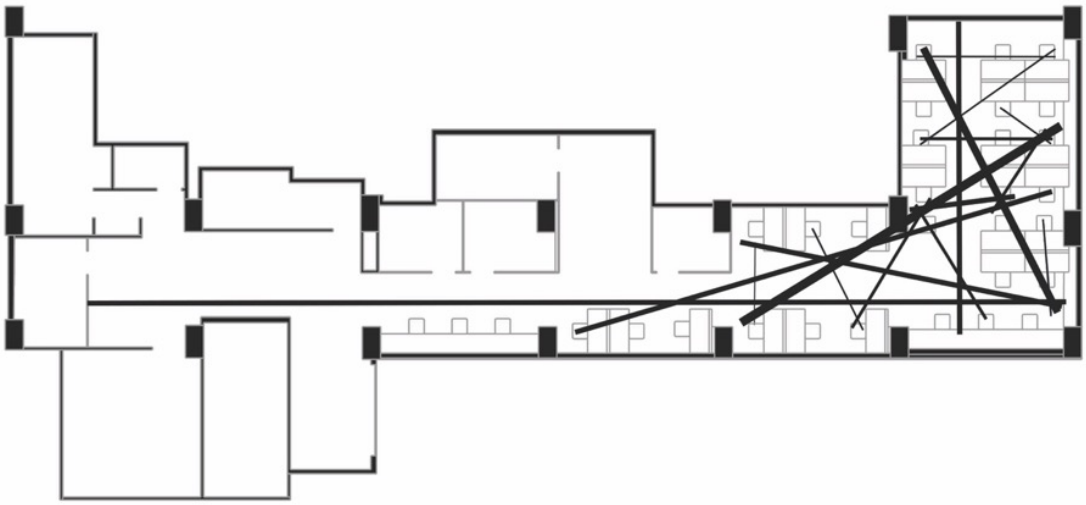


Figure 31. Work-process interaction diagram for Oncüoğlu Architects

In the final part of the survey, employees answered questions about how the coronavirus pandemic affected their working conditions, workspace perceptions, and interactions with their colleagues in the open-plan office.

Considering ***working conditions***, all employees (15/15) stated that the coronavirus pandemic affected their working process.

> "The pandemic affected my working conditions negatively because the duration of decision-making and problem-solving increased." *(Employee 1, Male, 39)*
>
> "I can concentrate on work more when interacting with my colleagues decreased because of the pandemic." *(Employee 4, Female, 33)*
>
> "The social interactions with my colleagues decreased after the coronavirus pandemic. Therefore, I lost my motivation at work." *(Employee 15, Female, 28)*

> "Our workspaces' locations changed to maintain social distance. Therefore, my privacy improved in the open-plan office." *(Employee 12, Female, 27)*
>
> "My productivity decreased because of social distancing." *(Employee 15, Female, 28)*
>
> "The coronavirus pandemic proved that it is possible to work from different locations in addition to the office." *(Employee 5, Female, 35)*

Considering ***perceptions of workspaces***, three out of 15 employees indicated that the coronavirus pandemic did not affect their working processes.

Other employees (12/15) mentioned that the pandemic changed their perceptions of work both positively and negatively.

> "I feel comfortable with my office because of the office's size. I would be nervous if I had to work in a smaller open-plan office in size." *(Employee 3, Female, 23)*
>
> "I do not allow other colleagues to invade my personal workspace because of the coronavirus pandemic." *(Employee 4, Female, 33)*
>
> "I understand the importance of the office space for productivity after working from home because of the pandemic." *(Employee 9, Female, 26)*
>
> "Our open-plan office seems unsafe because of inadequate enclosures." *(Employee 10, Female, 28)*
>
> "The office space is not always necessary to work. I can work wherever I want with an internet connection and personal computer." *(Employee 11, Female, 28)*

> "We always had to wear masks because we do not have enclosed workspaces in the office. Therefore, wearing masks results in distress while working in the office." *(Employee 12, Female, 27)*

Considering ***interactions with colleagues***, 11 out of 15 employees stated that their interactions with their colleagues decreased because of the coronavirus pandemic.

> "I start to avoid being in crowded areas in the office if it is possible." *(Employee 2, Male, 30)*

> "The duration of interactions with my colleagues decreased after the pandemic." *(Employee 3, Female, 23)*

> "We become more conscious of the distance between us while working." *(Employee 7, Female, 25)*

> "I start to increase my physical distance from other colleagues. I was sharing my island table with my three colleagues before the pandemic. However, only two employees use the same table after the pandemic." *(Employee 15, Female, 28)*

The other employees (4/15) stated that the coronavirus pandemic did not affect interaction with colleagues in the open-plan office. They also stated that the only change after the pandemic was wearing masks.

4.1.2. Results of Tepe Home

Qualitative findings for Tepe Home were gathered and analyzed.

4.1.2.1. Observation

The observation process in Tepe Home took half a day. The location of workspaces in the open-plan office was observed and recorded while employees were not in the office during the first phase of the observation (see Figure 32). In the open-plan office of Tepe Home, there was no partition between the desk of employees. Thus, insufficient visual privacy resulted in unwanted observation while working in their open-plan office.

The second phase of the observation was conducted when employees worked in the open-open office. The observation started at 9.30 am and ended with the employees' lunch break at 11.30 pm. This time slot was chosen because it was the time when most of the employees worked in the office. During the second phase, there were 15 employees in the office. The type of interactions and locations of these interactions were recorded while sitting at the observation point. At the beginning of the observation, the employee at desk 14 asked a work-related question to her colleague sitting at desk 13. The duration of this interaction was about 2-3 minutes. At the same time, two other employees sitting at desks 4 and 5 started to interact for the work processes, and their interaction continued for almost 10 minutes. Then employees at desks 6 and 8 interacted to clarify an issue related to work, and the duration of this interaction was about 15 minutes. Before the lunch break, some of the employees interacted socially to decide where to eat during their lunch break. It was observed that most of the interaction during the observation took place between employees who sat at desks close to each other.

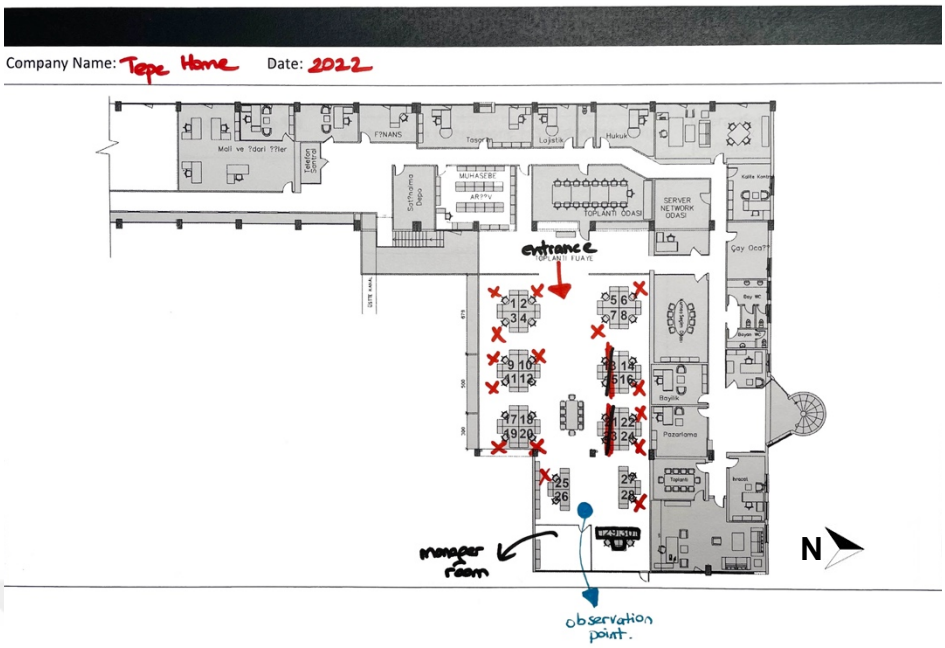


Figure 32. Observation sheet for Tepe Home

4.1.2.2. Survey

As previously mentioned, a survey on employee perceptions of workspaces and work-process interactions was distributed to Tepe Home employees after the observation. At the end of the survey, open-ended questions were analyzed qualitatively.

For the first part of the survey, answers to questions related to employee perceptions of workspaces were coded and grouped into six categories: (1) visual privacy, (2) acoustical privacy, (3) noise, (4) distraction, (5) crowding and (6) personal space and territoriality (see Figure 33).

Considering ***visual privacy,*** seven out of 15 employees stated that they had problems in their offices.

> "Being subjected to unwanted observation while working makes me uncomfortable. Not having one of the private offices in the building is not fair." *(Employee 3, Male, 35)*

> "I do not like working in an open-plan office because of inadequate visual barriers." *(Employee 5, Male, 50)*

> "Visual privacy is crucial in work confidentiality." *(Employee 12, Male, 28)*

Moreover, eight employees evaluated their workspaces positively according to visual privacy.

> "Working in an open-plan office made interacting with my colleagues from different departments easier." *(Employee 2, Male, 49)*

> "According to me, more interaction with my colleagues means more productivity while working. Thus, I am happy with the office." *(Employee 11, Male, 24)*

> "I am comfortable with our open-plan office in terms of visual privacy." *(Employee 13, Female, 25)*

> *"*It is not a problem for me to work in an open-plan office." *(Employee 15, Female, 29)*

Considering ***acoustical privacy***, nine out of 15 employees stated that they felt uncomfortable.

"We do not have acoustical privacy in our office. We can easily overhear part of our colleagues' conversations." *(Employee 3, Male, 35)*

"Making a personal phone call is difficult in our office." *(Employee 5, Male, 50)*

*"*Not being able to have private conversations is uncomfortable." *(Employee 8, Female, 30)*

"I had to go to our meeting room for my personal phone calls." *(Employee 14, Female, 36)*

Three out of 15 employees were satisfied with acoustical privacy in the open-plan office.

"I do not need acoustical privacy while working in our open-plan office." *(Employee 7, Male, 31)*

"I am satisfied with acoustical privacy in our office, although we have poor acoustical privacy." *(Employee 15, Female, 29)*

The other three employees were neutral about the acoustical privacy in their offices.

Considering ***noise***, seven out of 15 participants mentioned that they were uncomfortable with background noise in the open-plan office.

"When noise increases in the office, I use earphones while working." *(Employee 1, Male, 43)*

"I cannot focus on a task because of background noise in our office." *(Employee 3, Male, 35)*

"I listen to music while working because I cannot concentrate on the drawing." *(Employee 8, Female, 30)*

"Noise becomes annoying when many of my colleagues in the office make noise simultaneously." *(Employee 13, Female, 25)*

Eight of 15 employees stated they were not distracted from overhearing other employees' conversations.

"Although I am subjected to noise while working, using earphones helps me to concentrate on the task." *(Employee 7, Male, 31)*

"Noise in the office does not disturb me while working." *(Employee 10, Male, 38)*

Considering ***distraction***, 11 out of 15 employees stated that they lost their attention to the work task in the open-plan office:

"I am distracted from my work three or five times a day." *(Employee 4, Male, 46)*

"I lose my attention once or twice a day while working in the office." *(Employee 6, Male, 36)*

"I get distracted by my other colleagues up to three times a day." *(Employee 7, Male, 31)*

"I am getting interrupted at work by the questions of my colleagues as my desk is always visible to everyone in the office." *(Employee 9, Female, 27)*

Four out of 15 employees mentioned that they were not distracted from their work in the open-plan office.

> "I mostly do not get distracted from my work in the office when I fully concentrate." *(Employee 5, Male, 50)*
>
> "I do not lose my attention because I am using headphones." *(Employee 1, Male, 43)*

Considering ***crowding***, seven out of 15 employees stated that the increasing number of employees around their workstations did not affect them negatively.

> "Experiencing crowds in the open-plan office does not make me uncomfortable while I am working." *(Employee 1, Male, 43)*
>
> "The increasing number of employees increases my motivation." *(Employee 12, Male, 28)*

Five out of 15 employees mentioned they felt uncomfortable when the number of employees around them increased.

> "I am disturbed by the increasing number of employees." *(Employee 9, Female, 27)*
>
> "I lose my attention when I see my colleagues around my desk in the office." *(Employee 13 , Female, 25)*

The other three employees were neutral about the crowding in their offices.

Considering ***personal space and territoriality***, thirteen out of 15 employees mentioned they felt uncomfortable, upset, and unmotivated when they lost the sense of control over their workspace.

"I lose my motivation for working on a task in the office." *(Employee 3, Male, 35)*

"I lose concentration when I have inadequate personal space in the office." *(Employee 6, Male, 36)*

"I develop territorial behaviors when I lose the sense of control over my desk in the office." *(Employee 12, Male, 28)*

One out of 15 employees expressed that losing control over personal workspaces did not affect his/her negatively.

"I maintain my personal space at work." *(Employee 8, Female, 30)*

Another employee was neutral about losing control over his/her desk in the open-plan office.

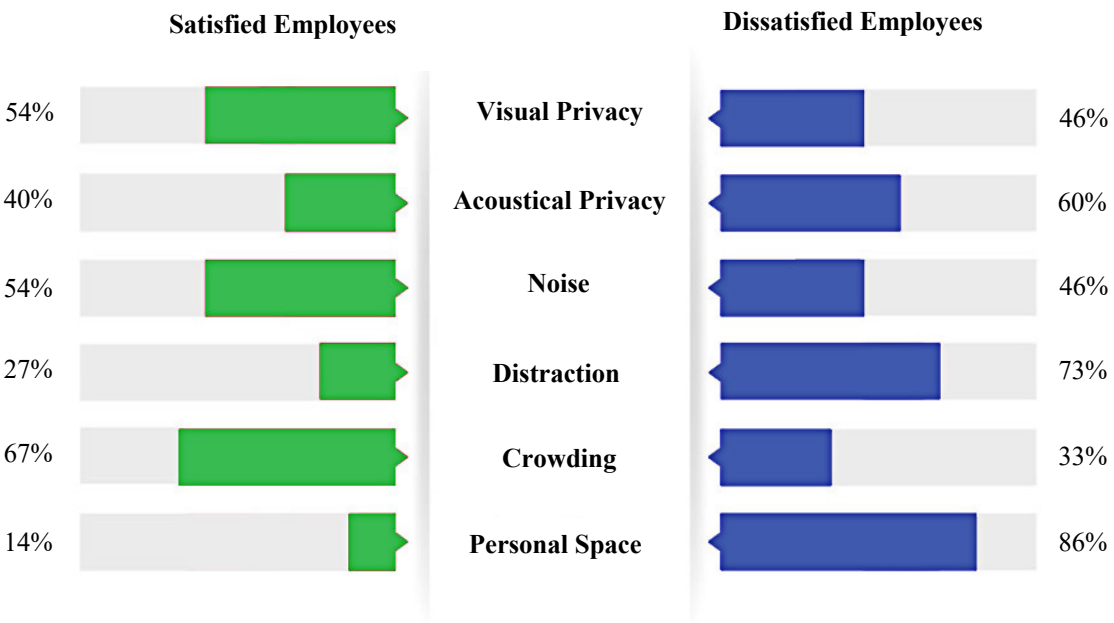


Figure 33. Summary of survey results for Tepe Home

The second part of the survey was formed to identify work-process interactions in the office. According to employees' answers, lines connecting the workstation of respondents to their colleagues with whom they interacted the most were drawn. A diagram illustrating employees' work-process interaction patterns was generated (Figure 34). When lines become denser in an area on the plan, they demonstrate higher work-process interactions.

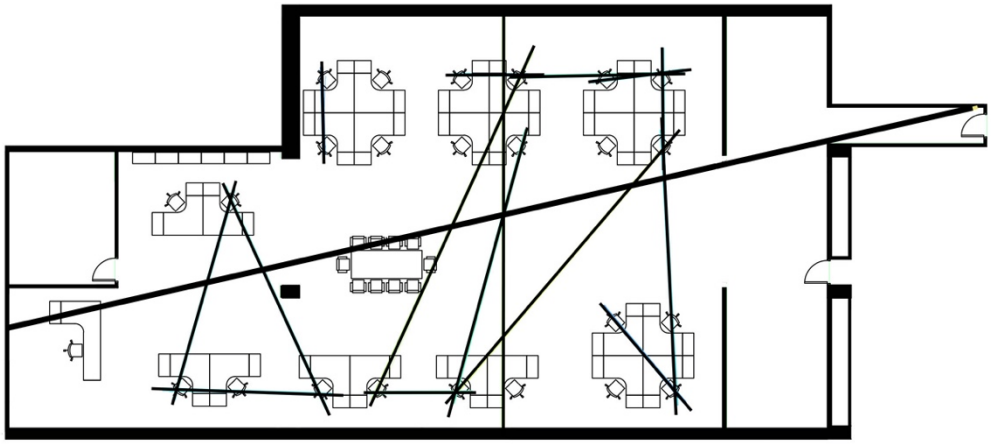


Figure 34. Work-process interaction diagram for Tepe Home

In the final part of the survey, employees answered questions about how the coronavirus pandemic affected their working conditions, workspace perceptions, and interactions with their colleagues in the open-plan office.

Considering ***working conditions***, four out of 15 employees stated that the coronavirus pandemic did not affect their working process.

Other employees (11/15) mentioned that the coronavirus pandemic negatively affected their working process.

"Trying to maintain social distance in the office during work-process interactions was very stressful." *(Employee 5, Male, 50)*

"It was very annoying to wear masks while working in the office. It affected our work performance negatively." *(Employee 6, Male, 36)*

"Interaction with our colleagues decreased as a result of the pandemic." *(Employee 7, Male, 31)*

"We were more anxious than other employees working in private offices." *(Employee 8, Female, 30)*

Considering ***perceptions of workspaces***, seven out of 15 employees indicated that the coronavirus pandemic did not affect their working processes.

Other employees (8/15) mentioned that the pandemic changed their perceptions of work both positively and negatively.

"The coronavirus pandemic showed the importance of the physical work environment in the office. I understood how crucial to interact with our colleagues while working." *(Employee 1, Male, 43)*

"I understood I could be more productive in the office than working from home." *(Employee 7, Male, 31)*

"I realized that I prefer to work in a private office rather than an open-plan office as private offices provide more isolation." *(Employee 8, Female, 30)*

"I do not feel uncomfortable in the office after the pandemic." *(Employee 9, Female, 27)*

> "Being anxious in the office because of the coronavirus pandemic resulted in lower productivity." *(Employee 14, Female, 36)*

Considering ***interactions with colleagues***, 11 out of 15 employees stated that their interactions with their colleagues decreased because of the coronavirus pandemic.

> "As face-to-face interaction is better than a phone call to resolve conflicts related to work, decreased face-to-face interaction with colleagues in the office affected work processes negatively." *(Employee 1, Male, 43)*

> "I had to increase the physical distance from other colleagues in the office." *(Employee 5, Male, 50)*

> "I avoid joining my colleagues at lunch or break. Thus, my social interactions with other colleagues also decreased." *(Employee 8, Female, 30)*

The other employees (4/11) stated that the coronavirus pandemic did not affect interaction with colleagues in the open-plan office. They also indicated that they continued to interact with their colleagues wearing masks.

4.2. Quantitative Findings

Quantitative data was gathered from employees of two different open-plan offices via generic visibility analysis, targeted visibility analysis, and the survey. The results of generic and targeted visibility were maps of the color spectrum and tables. In order to form the work-process interactions diagrams, survey questions on work-

process interactions were analyzed through axial analysis. These outputs of quantitative analysis were compared with the survey findings in two ways:

(1) Color spectrum maps derived from generic and targeted visibility analysis were compared with interaction diagrams obtained through the survey to understand the similarities and differences graphically between maps. These maps of the color spectrum were compared according to their color range.

(2) Outputs of generic visibility, targeted visibility, and responses to the survey's multiple-choice test questions were analyzed using Statistical Package for Social Sciences (SPSS) software. First, degree, density, outdegree, binocular density, targeted visibility ratio (150 cm), targeted visibility ratio (60 cm), visual integration, and connectivity were obtained and transferred to SPSS. Then, bootstrapped correlation analysis, Eta coefficient test, and regression analysis were conducted in order to understand the relationships between the dependent variable and independent variables (see Appendix G).

4.2.1. Results of Öncüoğlu Architects

Quantitative findings for Öncüoğlu Architects were gathered and analyzed.

4.2.1.1. Generic Visibility Analysis Findings

The results were analyzed according to Visibility Graph Analysis, Degree, and Density.

Visibility Graph Analysis (VGA)

DepthMap software was used as an instrument for generic visibility analysis. Connectivity and Visual Integration HH values in the open-plan office were determined in order to compare visual privacy levels with work-process interactions. The visual integration tool was used to assess visual privacy levels within the office. Following the generic visibility analysis, color spectrum maps illustrating visual integration and connectivity values in the open-plan office were obtained. Maps of the color spectrum were compared qualitatively through color evaluations from blue to red. The red areas indicated higher visual integration and connectivity levels, while the blue ones indicated lower visual integration and connectivity values.

Based on the color ranges depicted through a generic visibility map (see Figure 35), employees at desks 4, 5, 8, 11, 12, 13, 14, and 15 (in turquoise areas) had low visual integration values in the open-plan office. Employees at desks 1, 2, 3, 9, and 10 (in green areas) had moderate visual integration values. Moreover, employees at desks 6 and 7 (in red areas) had high visual integration values in the open-plan office. Visual integration indicated how visually connected all spaces are on the map. High visual integration values demonstrate low visual privacy levels. Therefore, employees at desks 4, 5, 8, 11, 12, 13, 14, and 15 had high visual privacy levels, while employees at desks 6 and 7 had low visual privacy levels in the office.

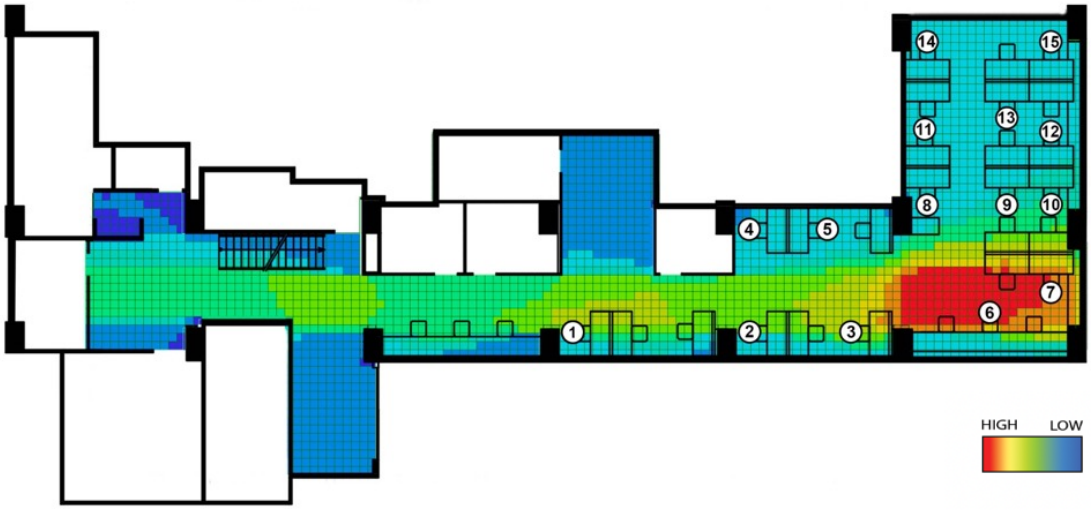


Figure 35. Generic visibility map of Öncüoğlu Architects illustrating visual integration

As explained previously, connectivity indicated the number of spaces connected to the origin space. According to the color ranges on the visibility graph of connectivity (Figure 36), employees at desks 4, 5, 8, 11, 14, and 15 (in turquoise areas) had low connectivity values in the office. The employees at desk 6 and desk 7 (in red areas) had high connectivity values.

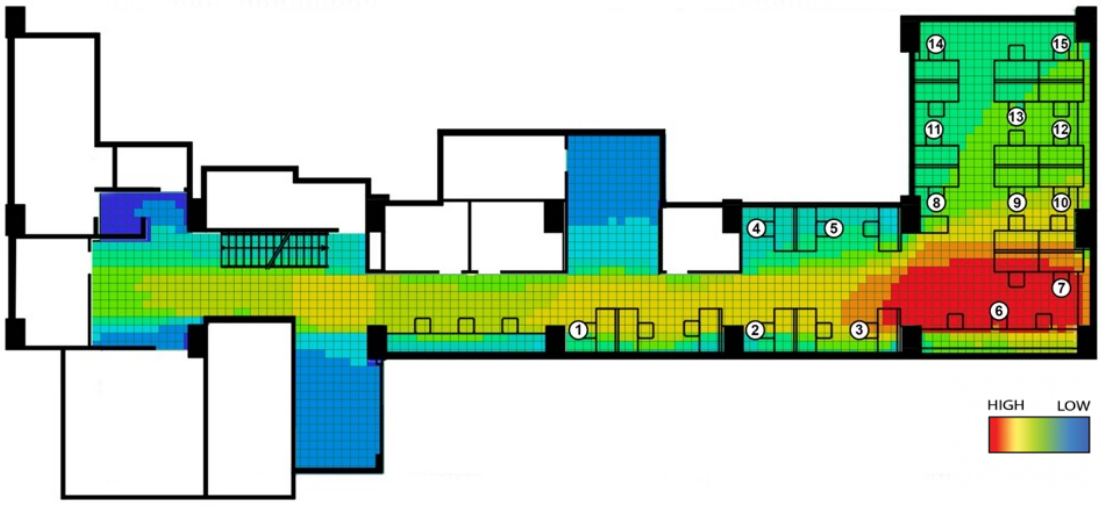


Figure 36. Generic visibility map of Öncüoğlu Architects illustrating connectivity

In addition to the color spectrum maps, visual integration, and connectivity values are depicted in Table 5. These numerical values support the outcomes of the maps of the color spectrum; as well as, they provide precise values to compare different desks according to their visual privacy levels. Desk 6 (Visual Integration HH: 26.28) had the highest visual integration value in the office. Thus, the employee sitting at the desk 6 had the lowest visual privacy level compared to other desks in the open-plan office. Desk 4 (Visual Integration HH: 9.00) had the lowest visual integration value compared to the other desks. Therefore, the employee sitting at the desk 4 had the highest visual privacy level in the office.

These numerical values were used in the quantitative analysis part of the study and transferred to SPSS for correlation analysis and regression tests.

Table 5. Visual Integration HH and Connectivity values of desks by DepthMap in Öncüoğlu Architects

Desk Number	Visual Integration HH	Connectivity
1	18.00	1302.00
2	17.32	1256.00
3	20.63	1455.00
4	9.00	547.00
5	9.81	652.00
6	26.28	1679.00
7	25.71	1661.00
8	9.84	884.00
9	12.11	1069.00
10	12.88	1172.00
11	9.44	823.00
12	10.19	938.00
13	9.96	899.00
14	9.49	836.00
15	9.87	880.00

Degree (n)

Degree indicates the number of people someone is directly connected with (Wasserman & Faust, 1994). In the context of this study, it indicates the number of directly visible employees sitting. Therefore, the number of visible desks from the selected desk within the 360° isovists was calculated. In other words, it shows the number of employees someone is surrounded by while working at his/her desk.

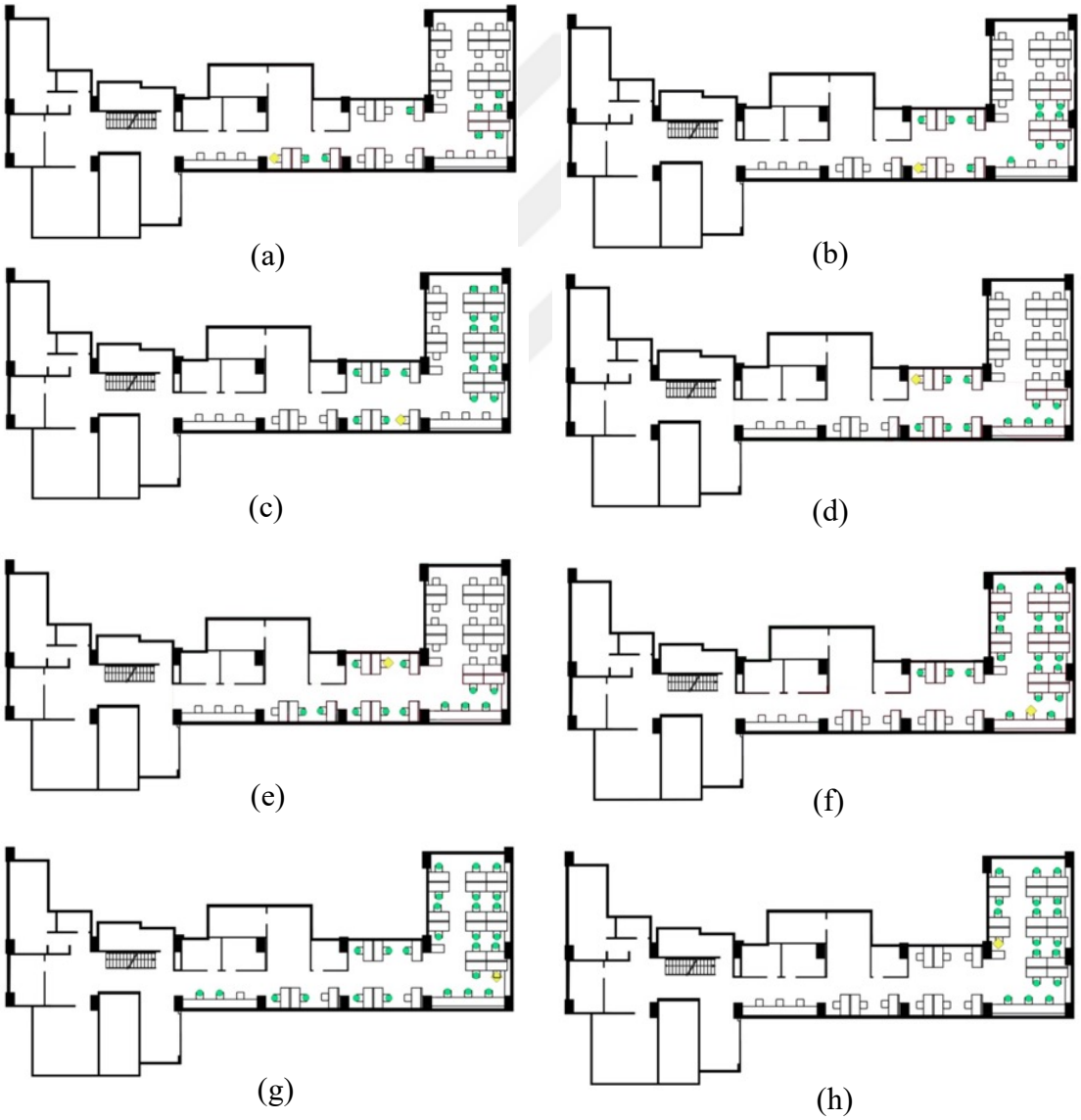


Figure 37. Degree analyses for different desks of Öncüoğlu Architects: (a) Desk 1, (b) Desk 2, (c) Desk 3, (d) Desk 4, (e) Desk 5, (f) Desk 6, (g) Desk 7, and (h) Desk 8

Figure 38. Degree analyses for different desks of Öncüoğlu Architects: (a) Desk 9, (b) Desk 10, (c) Desk 11, (d) Desk 12, (e) Desk 13, (f) Desk 14, and (g) Desk 15

Figures 37 and 38 show the number of visible desks from 360° isovist area. Visible desks were indicated with green dots, while the selected desks were symbolized with a yellow square. In addition to graphs, degree values are presented in Table 6. Desk 7 had the highest degree value in the office, while desk 1 had the lowest. In other words, the employee who sat at desk 7 had more visible desks within the 360° isovist. Moreover, this employee was surrounded by the highest number of employees in the open-plan office.

Table 6. Degree values of desks in Öncüoğlu Architects

Desk Number	Degree (Unit: Number of desks)
1	8.00
2	11.00
3	17.00
4	10.00
5	12.00
6	21.00
7	27.00
8	18.00
9	22.00
10	24.00
11	18.00
12	20.00
13	19.00
14	17.00
15	19.00

Density (n/m^2)

Density indicates the number of people per square meter (Wasserman & Faust, 1994). First, the 360° isovist areas were obtained for each desk in the office. Then, density was calculated by the ratio of the degree to the area of the 360° isovist.

Figure 39. Density analyses for different desks of Öncüoğlu Architects: (a) Desk 1, (b) Desk 2, (c) Desk 3, (d) Desk 14, (e) Desk 5, (f) Desk 6, (g) Desk 7, and (h) Desk 8

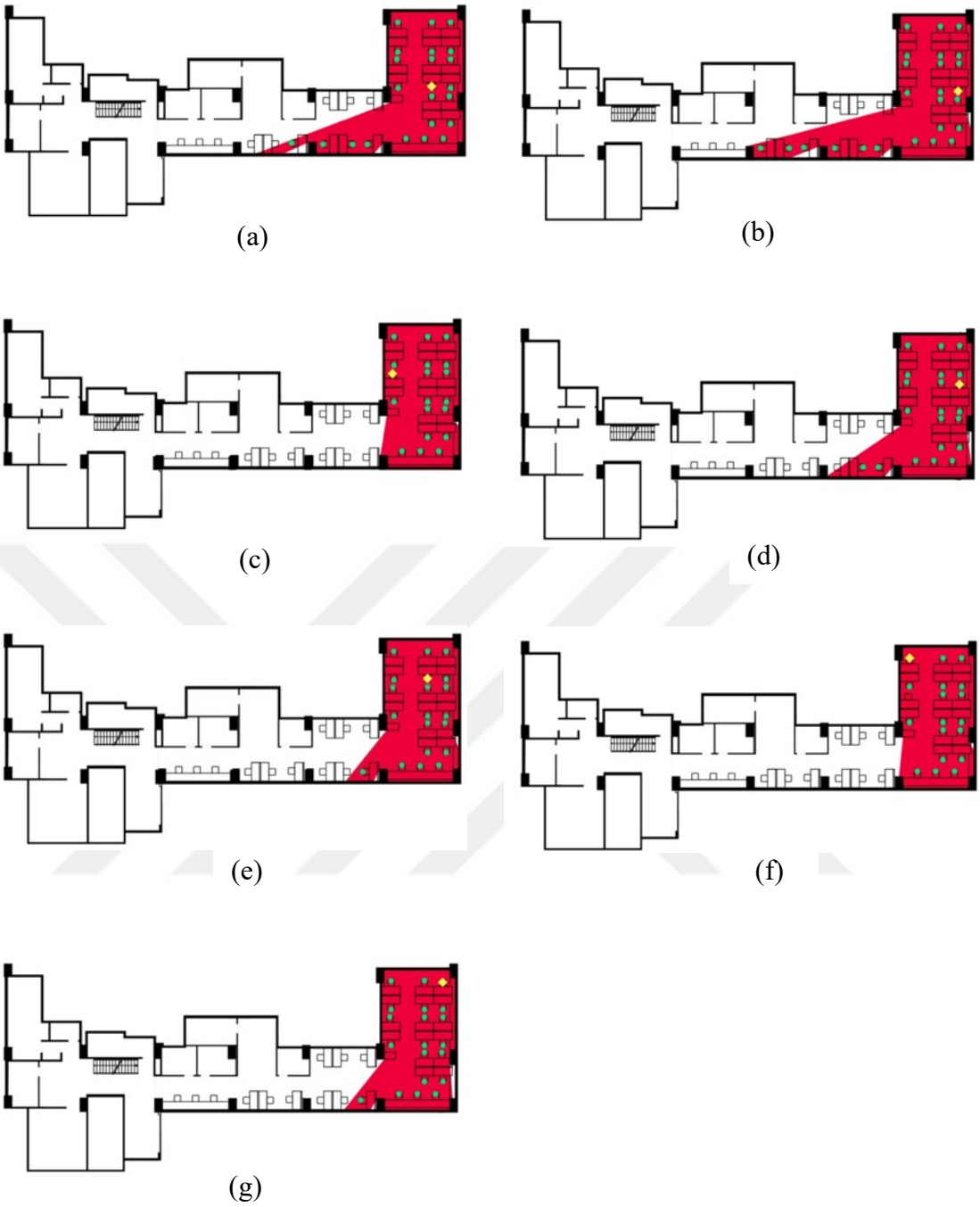


Figure 40. Density analyses for different desks of Öncüoğlu Architects: (a) Desk 9, (b) Desk 10, (c) Desk 11, (d) Desk 12, (e) Desk 13, (f) Desk 14, and (g) Desk 15

As seen in Figures 39 and 40, 360° isovists were drawn for each desk. Following the isovist analysis, the area of each isovist was calculated through DepthMapX. Then, density was obtained by the ratio of the degree to the area (Table 7). Desks 11, 13,

and 15 had high density values, while desk 1 had the lowest density value in the office.

Table 7. Density values of desks in Öncüoğlu Architects

Desk Number	Area (360° isovist) (m^2)	Density
1	85.4062	0.09
2	77.8707	0.14
3	107.7660	0.15
4	62.8961	0.15
5	70.2992	0.17
6	133.1650	0.15
7	137.8710	0.19
8	82.4071	0.21
9	101.880	0.21
10	110.4580	0.21
11	79.3392	0.22
12	91.6175	0.21
13	85.2985	0.22
14	78.9045	0.21
15	84.0443	0.22

4.2.1.2. Targeted Visibility Analysis Findings

The results were analyzed according to Outdegree, Binocular Density, and Targeted Visibility Analysis Tool.

Outdegree (n)

Outdegree indicates the number of desks directly visible to someone in binocular vision limits. In the context of this study, it indicates the number of directly visible employees sitting within the 120° forward-facing isovist (Wasserman & Faust, 1994). Therefore, outdegree represents the number of visible employees sitting at their desks while someone faces forward at their desks in the open-plan office. Visible desks were indicated with green dots, while the selected desks were symbolized with a yellow square.

Figure 41. Outdegree analyses for different desks of Öncüoğlu Architects: (a) Desk 1, (b) Desk 2, (c) Desk 3, (d) Desk 4, (e) Desk 5, and (f) Desk 6

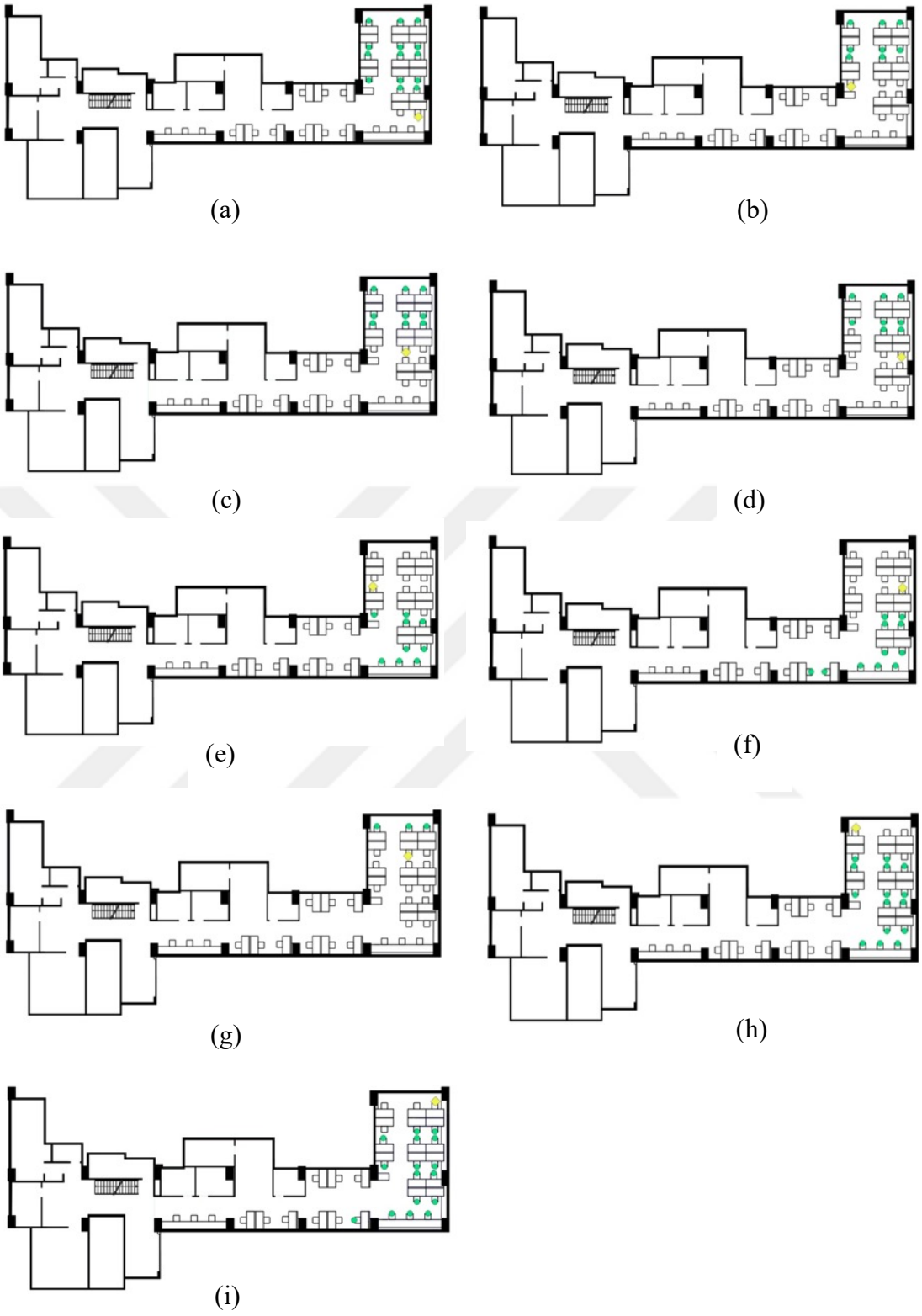


Figure 42. Outdegree analyses for different desks of Öncüoğlu Architects: (a) Desk 7, (b) Desk 8, (c) Desk 9, (d) Desk 10, (e) Desk 11, (f) Desk 12, (g) Desk 13, (h) Desk 14, and (i) Desk 15

As seen in Figures 41 and 42, the number of desks within the desks' 120° isovist was obtained. In addition to graphs, outdegree values are presented in Table 8. Desk 15 had the highest outdegree value, while desk 6 had the lowest outdegree value in the office. In other words, the employee who sat and faced forward at desk 15 had the highest number of visible employees sitting at their desks.

Table 8. Outdegree values of desks in Öncüoğlu Architects

Desk Number	Outdegree (Unit: Number of desks)
1	6.00
2	9.00
3	11.00
4	8.00
5	3.00
6	0.00
7	14.00
8	8.00
9	9.00
10	8.00
11	9.00
12	11.00
13	3.00
14	15.00
15	16.00

Binocular Density (120°) (n/m²)

Binocular density indicates the number of people per square meter. First, isovist areas for each workstation were calculated while employees faced forward. Following the partial isovist analysis, areas of the 120° isovist were obtained. Then, binocular density was calculated as the ratio of outdegree to the area of the 120° isovist.

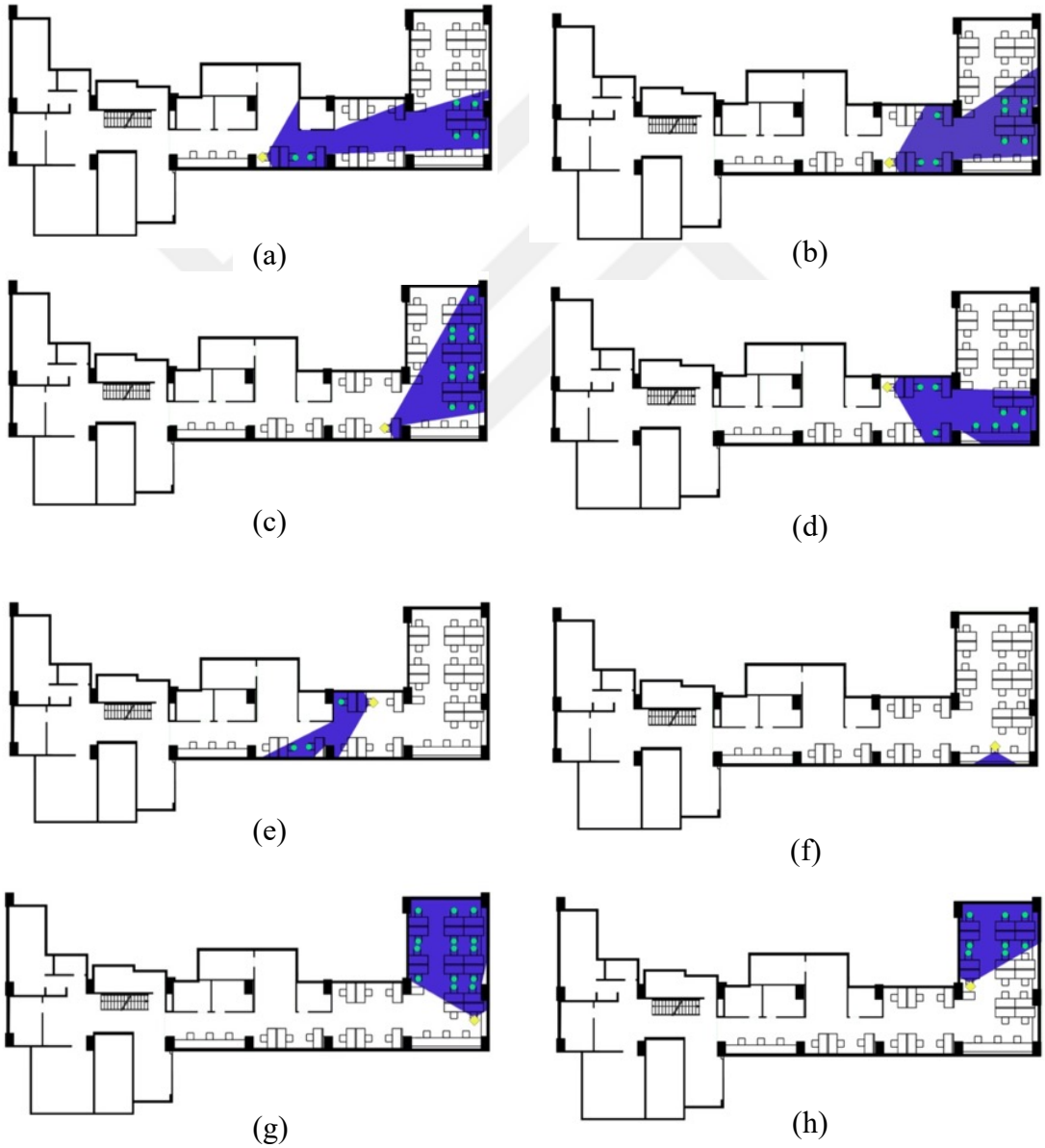


Figure 43. Binocular density analyses for different desks of Öncüoğlu Architects: (a) Desk 1, (b) Desk 2, (c) Desk 3, (d) Desk 4, (e) Desk 5, (f) Desk 6, (g) Desk 7, and (h) Desk 8

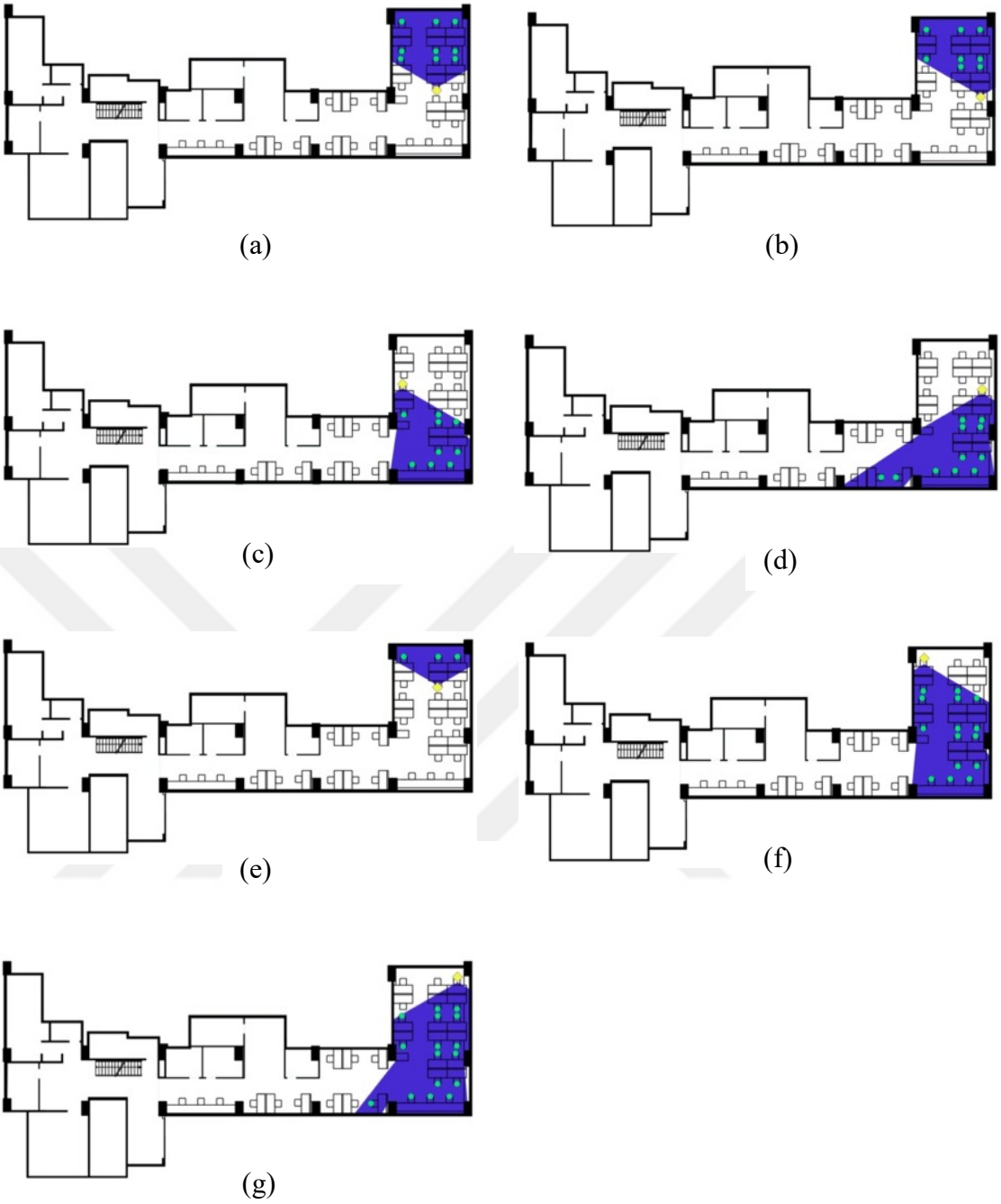


Figure 44. Binocular density analyses for different desks of Öncüoğlu Architects: (a) Desk 9, (b) Desk 10, (c) Desk 11, (d) Desk 12, (e) Desk 13, (f) Desk 14, and (g) Desk 15

Figures 43 and 44 show the area of the 120° isovist for each desk. Following the isovist analysis, the area of each isovist was calculated through DepthMapX. Then, binocular density was calculated by the ratio of the outdegree to the area (see Table

9). Desk 6 had the lowest binocular density value in the office, while desk 7 had the highest binocular density value in the office.

Table 9. Binocular density values of desks in Öncüoğlu Architects

Desk Number	Area (120° isovist) (m^2)	Binocular Density
1	60.1889	0.09
2	55.8116	0.16
3	50.0143	0.21
4	49.2844	0.16
5	18.5060	0.16
6	2.6303	0
7	53.2068	0.26
8	33.3671	0.23
9	36.4719	0.24
10	34.2418	0.23
11	40.7165	0.22
12	53.7288	0.20
13	16.1810	0.18
14	60.6337	0.24
15	66.5771	0.24

Targeted Visibility Analysis Tool

Targeted visibility analysis was undertaken to assess the visibility of specific visual elements (other employees sitting and walking) from each desk in the office. A newly developed Python script for DepthMap software facilitated this targeted visibility analysis. In contrast to generic visibility analysis, which considers overall visibility, targeted visibility analysis was conducted individually for each employee. At the end of the analysis, graphs, targeted visibility ratios of the 15 different desks, and the number of visible employees from these desks was obtained. Targeted visibility analysis was conducted for distances between walking and sitting targets. Social distance (150 cm) and personal distance (60 cm) were taken into consideration in order to understand if different distances affected targeted visibility values (Hall, 1969).

Figure 45. Targeted visibility analyses (150 cm) for different desks of Öncüoğlu Architects: (a) Desk 1, (b) Desk 2, (c) Desk 3, and (d) Desk 4

Figure 46. Targeted visibility analyses (150 cm) for different desks of Öncüoğlu Architects: (a) Desk 5, (b) Desk 6, (c) Desk 7, (d) Desk 8, (e) Desk 9, (f) Desk 10, (g) Desk 11, and (h) Desk 12

(a) (b)

(c)

Figure 47. Targeted visibility analyses (150 cm) for different desks of Öncüoğlu Architects: (a) Desk 13, (b) Desk 14, and (c) Desk 15

As seen in Figures 45, 46, and 47, 15 graphs were obtained in order to perform the targeted visibility analysis for 150 cm distance. Isovist areas for each desk were indicated in blue on the graphs, and visible employees in these isovist areas were represented with orange circles. In addition to the graphs, targeted visibility ratios and visible employees for 60 cm and 150 cm are shown in Table 10.

Following targeted visibility analysis at a distance of 150 cm, desk 13 had the highest targeted visibility ratio in the open-plan office. In other words, when facing forward, the employee sitting at desk 13 was likelier to see other colleagues in the office. When the number of visible employees increased, the visual privacy level of the employee sitting at desk 13 decreased. On the other hand, desk 6 had the lowest targeted visibility ratio. Moreover, according to targeted visibility analyses at a

distance of 150 cm, the employee sitting at desk 6 had the highest visual privacy level in the office. According to the results of targeted visibility analysis at a distance of 60 cm, desk 13 had the highest targeted visibility ratio in the office. In contrast, desk 6 had the lowest targeted visibility ratio at a distance of 60 cm.

Table 10. Results of targeted visibility analysis in Öncüoğlu Architects

Desk Number	TVR (150 cm)	Visible Agents (150 cm)	TVR (60 cm)	Visible Agents (60 cm)
1	0.040	27	0.248	166
2	0.035	22	0.249	155
3	0.035	20	0.255	142
4	0.031	17	0.253	139
5	0.034	7	0.252	52
6	0.000	0	0.000	0
7	0.040	24	0.252	149
8	0.043	16	0.256	95
9	0.041	17	0.259	105
10	0.042	16	0.252	96
11	0.037	17	0.251	114
12	0.031	19	0.234	140
13	0.050	9	0.278	50
14	0.037	25	0.250	169
15	0.033	25	0.240	178

4.2.1.3. Survey Findings

Survey questions related to work-process interactions were analyzed through axial analysis. The outputs of the survey were both maps and tables. Other multiple-choice test questions of the survey were analyzed descriptively.

Work-Process Interaction Diagram and Connectivity Levels

In order to determine work-process interaction patterns in the office, axial analysis was conducted through DepthMap. Circulation lines were drawn to complete all circulation lines and connect desks indicated by employees in the survey. For example, if the employee at desk 1 indicated that s/he interacted with the employee at desk 10 the most for work processes last year, a circulation line was drawn to connect desk 1 and desk 10 by hand. This step was completed for each work-process interaction mentioned in the survey. In addition, the two main circulation loops on the office floor plan were drawn.

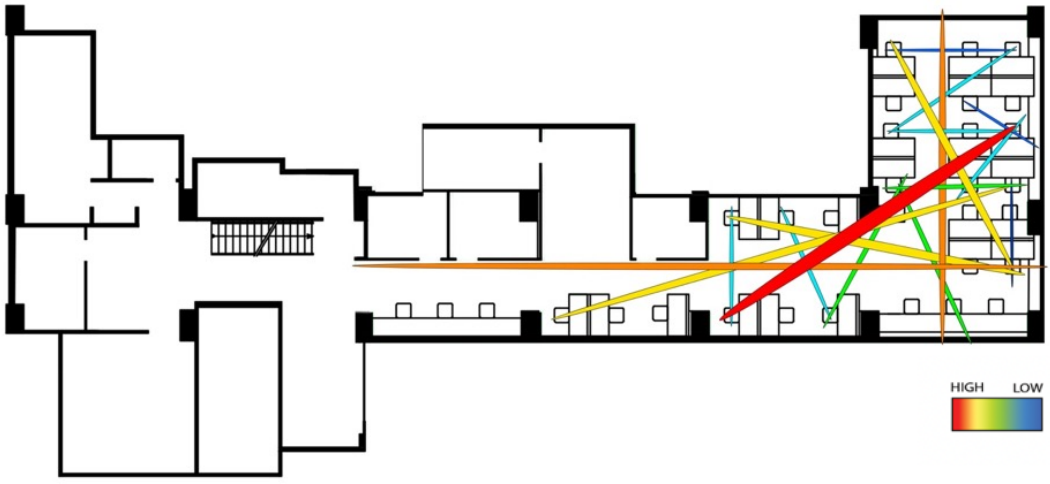


Figure 48. Work-process interaction diagram of Öncüoğlu Architects

Circulation lines were evaluated according to their connectivity levels. As shown in Figure 48, the graph was obtained as a result of the connectivity values of circulation lines. Thicker lines demonstrated a higher integration in the open-plan office. Integration affected the density of interaction in the setting (Grajewski, 1993). In addition to the graph, connectivity levels were also obtained numerically (Table 11). Connectivity values indicating the number of intersections each line makes with other lines were transferred to the SPSS for regression tests and correlation analysis.

Table 11. Connectivity levels through axial analysis in Öncüoğlu Architects

Desk Number I	Desk Number II	Connectivity
1	10	12.00
2	12	10.00
3	8	7.50
4	2	8.00
5	3	7.00
6	8	8.00
7	4	7.66
8	9	7.66
9	12	6.50
10	7	7.50
11	15	6.00
12	11	8.00
13	12	5.00
14	7	7.50
15	14	5.00

Descriptive Analysis of Multiple-choice Test Questions

According to the answers of employees, characteristics of work-process interactions are shown in Table 12. The duration of the indicated interaction was mostly between 11-20 minutes (n=7, 46.7%). The majority of the indicated interactions were with three or fewer employees (n=9, 60%). Indicated interactions were commonly unplanned interactions (n=12, 80%). Most employees interacted with their colleagues for work-processes (n=8, 53.3%). The main reason for these work process interactions was an improvement (n=11, 73.3%). Mainly, interactions occurred between employees in the same team (n=14, 93.3%).

Table 12. Interaction characteristics in Öncüoğlu Architects (n=15) (Yenel Guler & Demirkan, 2022, p. 10)

	Frequency	**Percentage**
Duration of the indicated interaction (minutes)		
0-10	6	40.0
11-20	7	46.7
21-30	2	13.3
The number of employees who take place in the indicated interaction		
Three or fewer employees	9	60
More than three employees	6	40
Organizing before the interaction		
Planned	3	20
Unplanned	12	80
The content of the interaction		
Work-process interaction	8	53.3
Social interaction	0	0
Both	7	46.7
The main reason to interact		
Expert advice	0	0
Improvement	11	73.3
Decision making	4	26.7
Innovation	0	0
The team of the employee who is interacted		
Same team	14	93.3
Different team	1	6.7

Eta Coefficient Test

Eta Coefficient test was conducted to determine the strength of association between interaction characteristics (independents) and the number of work-process interactions (dependent) since interaction characteristics were categorical variables based on Table 13.

Table 13. The Pearson's Correlation coefficient scale for use with the Eta Coefficient (Scott Jones, 2014)

Pearson's correlation coefficient	**Interpretation**
0.00	No association between the variables
0.01-0.19	No or negligible association between the variables
0.2-0.39	Weak association between the variables
0.4-0.69	Medium association between the variables
0.70-1.0	Strong association between the variables

Table 14 presents the results of the Eta Coefficient tests. There was a significant association between the duration of interaction (1-10/11-20/21-30) and the number of work-process interactions ($\eta = 0.608$). It suggests a moderate association between the variables. The duration of interaction attributes to 36% of the variance in work-process interactions ($\eta^2 = 0.36$).

There was a significant association between the number of employees who take place in the indicated interaction (three or less/more than three) and the number of work-process interactions ($\eta = 0.547$). It suggests a moderate association between the variables. The number of employees interaction attributes to 29% of the variance in work-process interactions ($\eta^2 = 0.29$).

There was a significant association between planned/unplanned interaction and the number of work-process interactions ($\eta = 0.278$). It suggests a weak association between the variables. Planned/unplanned interaction attributes to 7% of the variance in work-process interactions ($\eta^2 = 0.07$).

There was a significant association between the content of interaction (work-process/social/both) and the number of work-process interactions ($\eta = 0.254$). It suggests a weak association between the variables. The content of interaction attributes to 6% of the variance in work-process interactions ($\eta^2 = 0.06$).

There was a significant association between the reasons for interaction (expert advice/improvement/decision-making) and the number of work-process interactions ($\eta = 0.375$). It suggests a weak association between the variables. The reason for interaction attributes to 14% of the variance in work-process interactions ($\eta^2 = 0.14$).

There was a significant association between team type of interaction (same/different) and the number of work-process interactions ($\eta = 0.070$). It suggests a negligible association between the variables. The team of interaction attributes to 0.4% of the variance in work-process interactions ($\eta^2 = 0.004$).

Table 14. Results of the Eta Coefficient test

Correlations	Eta Coefficients	Explained Variance (%)
Duration of Interaction vs. Number of Work-process Interactions	0.608	36
Number of Employees Interact vs. Number of Work-process Interactions	0.547	29
Planned/Unplanned Interaction vs. Number of Work-process Interactions	0.278	7
Content of Interaction vs. Number of Work-process Interactions	0.254	6
Reason of Interaction vs. Number of Work-process Interactions	0.375	14
Team Type of Interaction vs. Number of Work-process Interactions	0.070	0.4

4.2.2. Results of Tepe Home Office

Quantitative findings for Tepe Home were gathered and analyzed.

4.2.2.1. Generic Visibility Analysis Findings

The results were analyzed according to Visibility Graph Analysis, Degree, and Density.

Visibility Graph Analysis (VGA)

Connectivity and Visual Integration HH values in the open-plan office of Tepe Home were determined in order to compare visual privacy levels with work-process interactions. The visual integration tool was used to assess visual privacy levels within the office. Following the generic visibility analysis, color spectrum maps illustrating visual integration and connectivity values in the open-plan office were obtained. Maps of the color spectrum were compared qualitatively through color evaluations from blue to red. The red areas indicated higher levels of visual integration and connectivity, whereas the blue areas indicated lower levels of visual integration and connectivity.

According to color ranges on the generic visibility map (Figure 49), desk 10 (in the dark blue area) had the lowest visual integration value in the office. In contrast, the employee at desk 5 (in the green area) had the highest visual integration value in the office. High visual integration values demonstrate low visual privacy. Therefore, the

employee at desk 10 had the highest visual privacy level, while the employee at desk 5 had the lowest visual privacy level in the office.

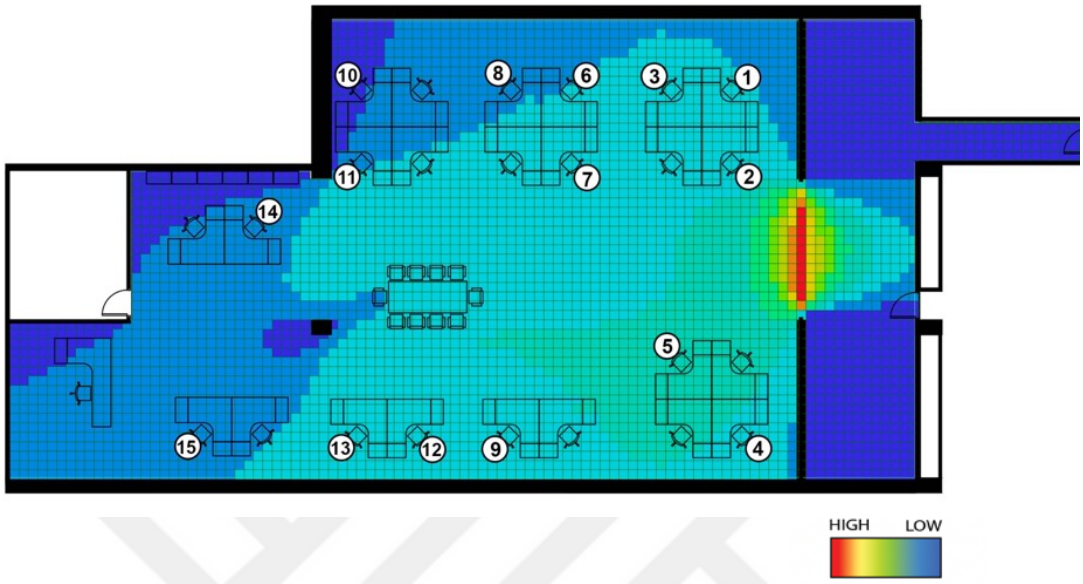


Figure 49. Generic visibility map of Tepe Home illustrating visual integration

In addition to the visual integration values, connectivity values were also obtained. According to the color ranges on the visibility graph of connectivity (Figure 50), the employee at desk 10 (in the light green area) had the lowest connectivity value in the office. The employees at desks 2, 5, 9, and 13 (in red areas) had high connectivity values.

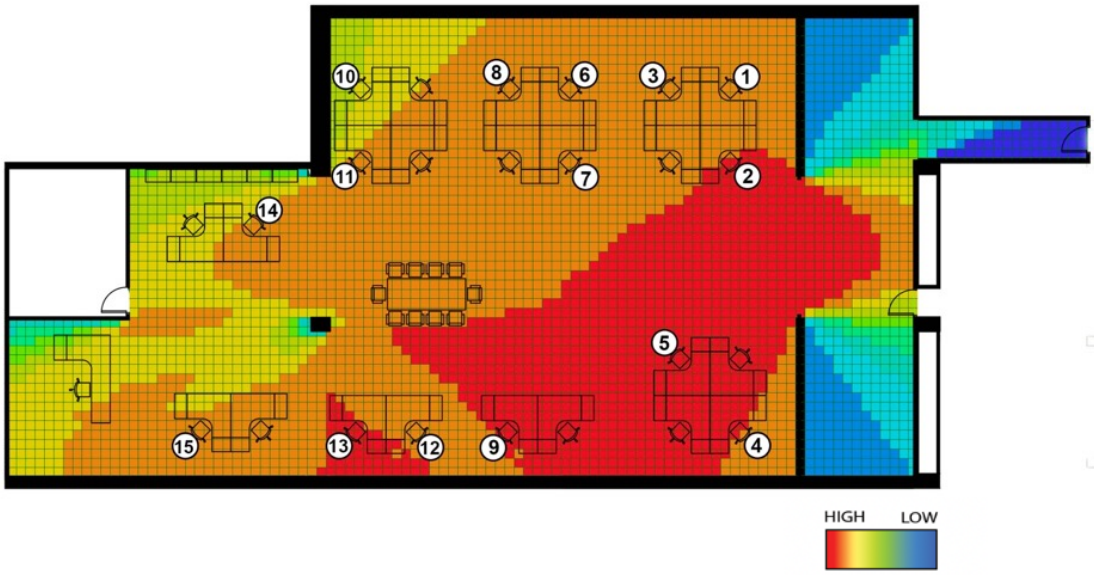


Figure 50. Generic visibility map of Tepe Home illustrating connectivity

Moreover, visual integration and connectivity values are depicted numerically in Table 15. These numerical values support the outcomes of the maps of the color spectrum; as well as, and they provide precise values to compare different desks according to their visual privacy levels. Desk 5 (Visual Integration HH: 86.54) had the highest visual integration value in the office. Thus, it had the lowest visual privacy level compared to other desks in the open-plan office. Desk 10 (Visual Integration HH: 29.52) had the lowest visual integration value than the other desks. Therefore, the employee sitting at desk 10 had the highest visual privacy level in the office. Visual integration values were imported into SPSS for correlation analysis and regression tests and used to identify the visual privacy levels of the different workstations in the open-plan office.

Table 15. Visual Integration HH and Connectivity values of desks by DepthMap in Tepe Home

Desk Number	Visual Integration HH	Connectivity
1	57.17	3397.00
2	70.32	3521.00
3	58.13	3408.00
4	69.93	3492.00
5	86.54	3596.00
6	55.17	3373.00
7	58.86	3416.00
8	51.78	3328.00
9	71.65	3505.00
10	29.52	2776.00
11	51.92	3330.00
12	69.68	3490.00
13	72.75	3513.00
14	42.25	3163.00
15	46.79	3224.00

Degree (n)

The number of visible desks from the selected desk within the 360° isovists was calculated, as seen in Figures 51 and 52. Visible desks were indicated with green dots, while the selected desks were symbolized with a yellow square.

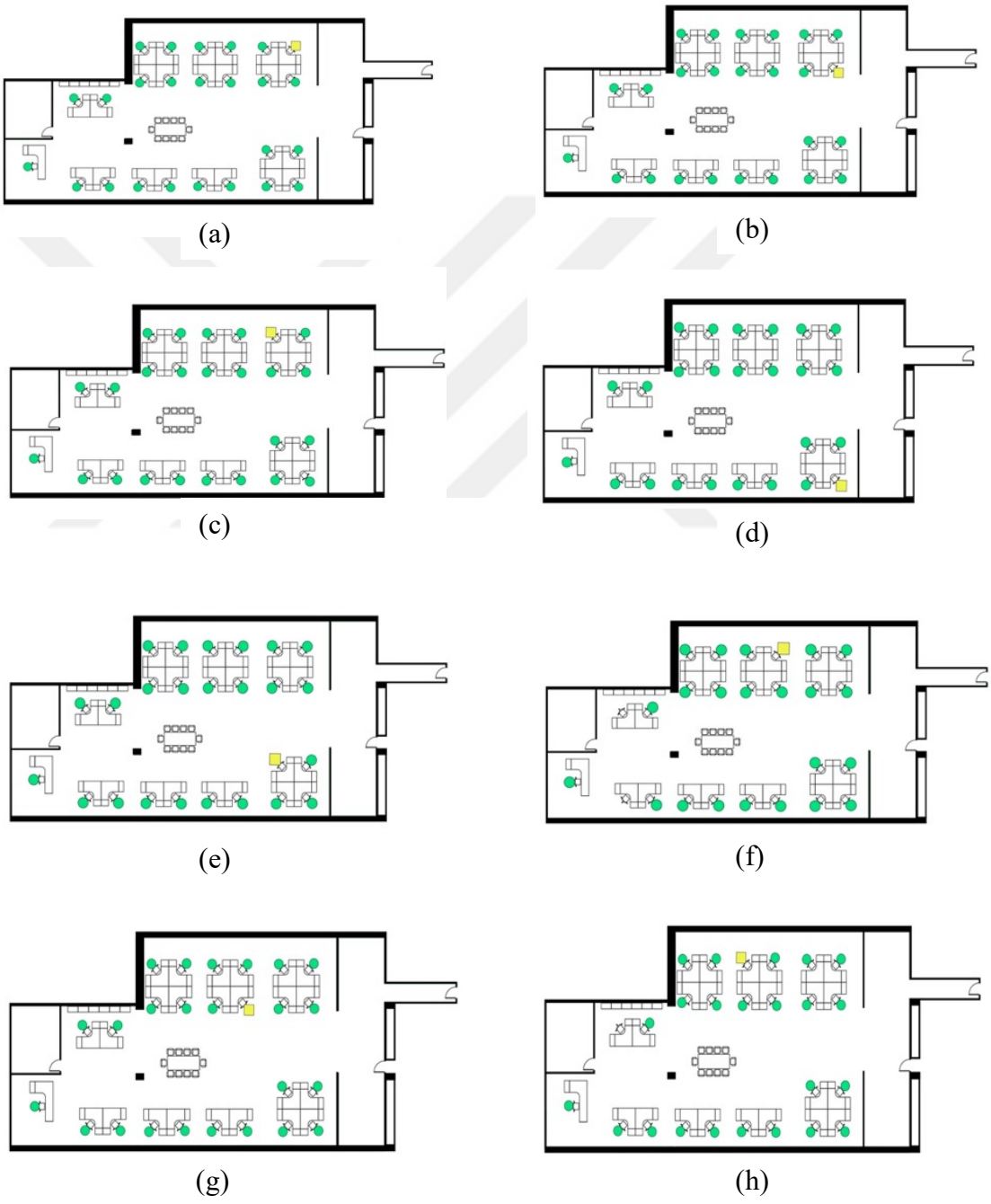


Figure 51. Degree analyses for different desks of Tepe Home: (a) Desk 1, (b) Desk 2, (c) Desk 3, (d)Desk 4, (e) Desk 5, (f) Desk 6, (g) Desk 7, and (h) Desk 8

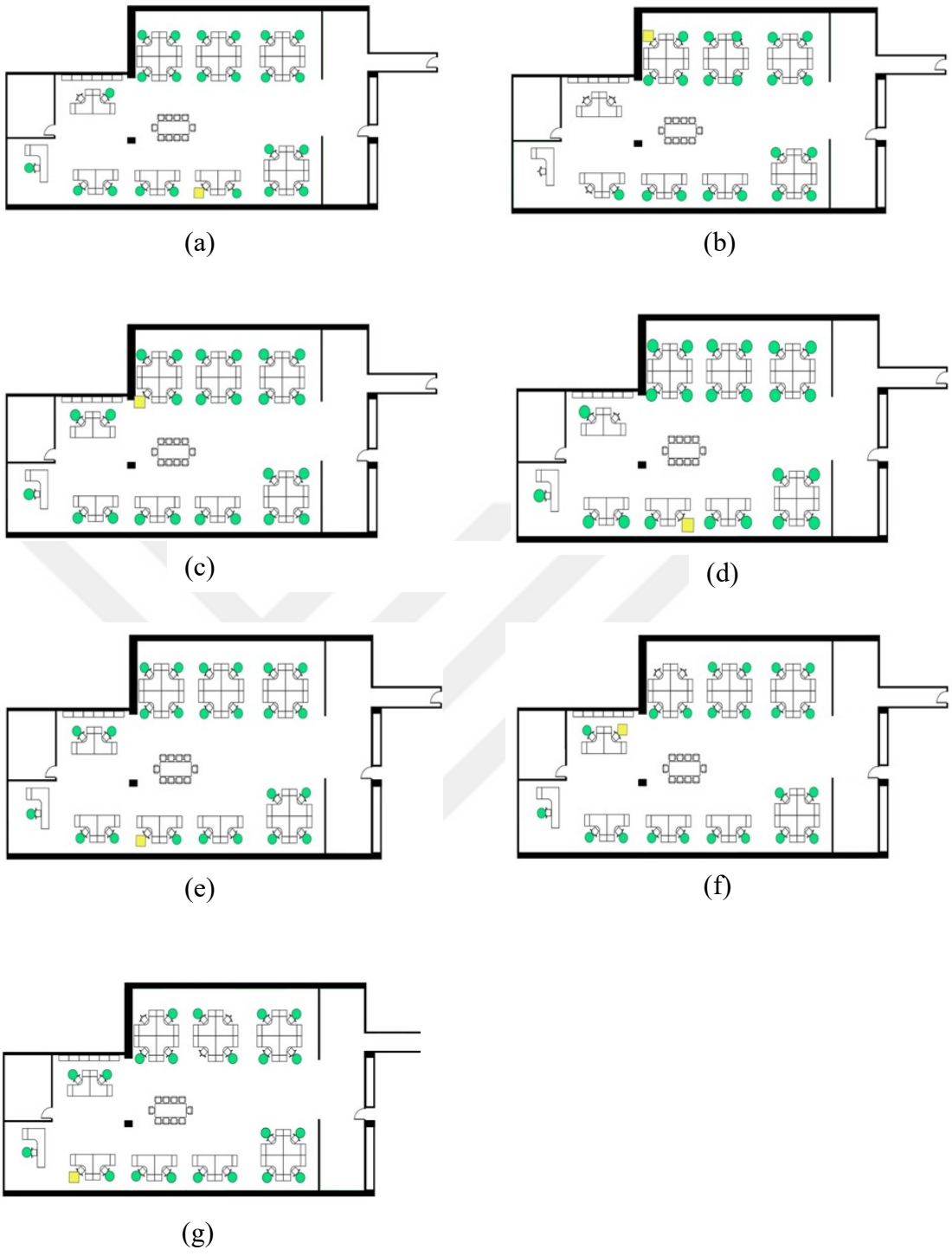


Figure 52. Degree analyses for different desks of Tepe Home: (a) Desk 9, (b) Desk 10, (c) Desk 11, (d) Desk 12, (e) Desk 13, (f) Desk 14, and (g) Desk 15

Figures 51 and 52 show that the number of desks within the desks' 360° isovist area was obtained. In addition to graphs, degree values are presented in Table 16. Desks 1, 2, 3, 4, 5, 7, 11, and 13 had high degree values, while desk 10 had the lowest degree value in the office. In other words, employees sitting at desks 1, 2, 3, 4, 5, 7, 11, and 13 had more visible desks within their' 360° isovist. Moreover, they were surrounded by the highest number of employees.

Table 16. Degree values of desks in Tepe Home

Desk Number	Degree (Unit: Number of desks)
1	24.00
2	24.00
3	24.00
4	24.00
5	24.00
6	22.00
7	24.00
8	23.00
9	23.00
10	20.00
11	24.00
12	23.00
13	24.00
14	22.00
15	21.00

Density (n/m²)

Density was calculated by the ratio of the degree to the area of the 360° isovist after areas of the 360° isovist were obtained for each desk in the office.

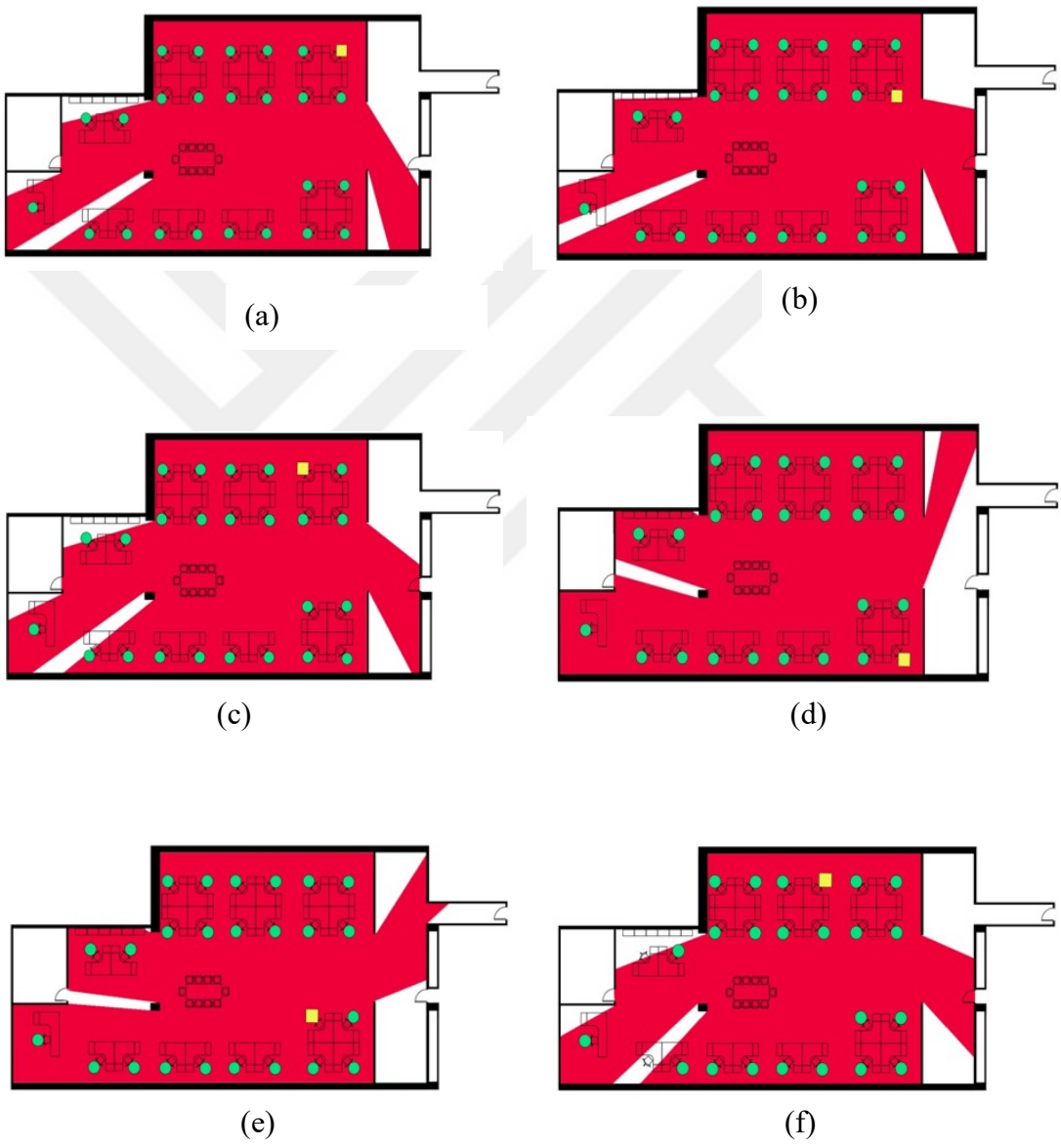


Figure 53. Density analyses for different desks of Tepe Home: (a) Desk 1, (b) Desk 2, (c) Desk 3 (d) Desk 4, (e) Desk 5, and (f) Desk 6

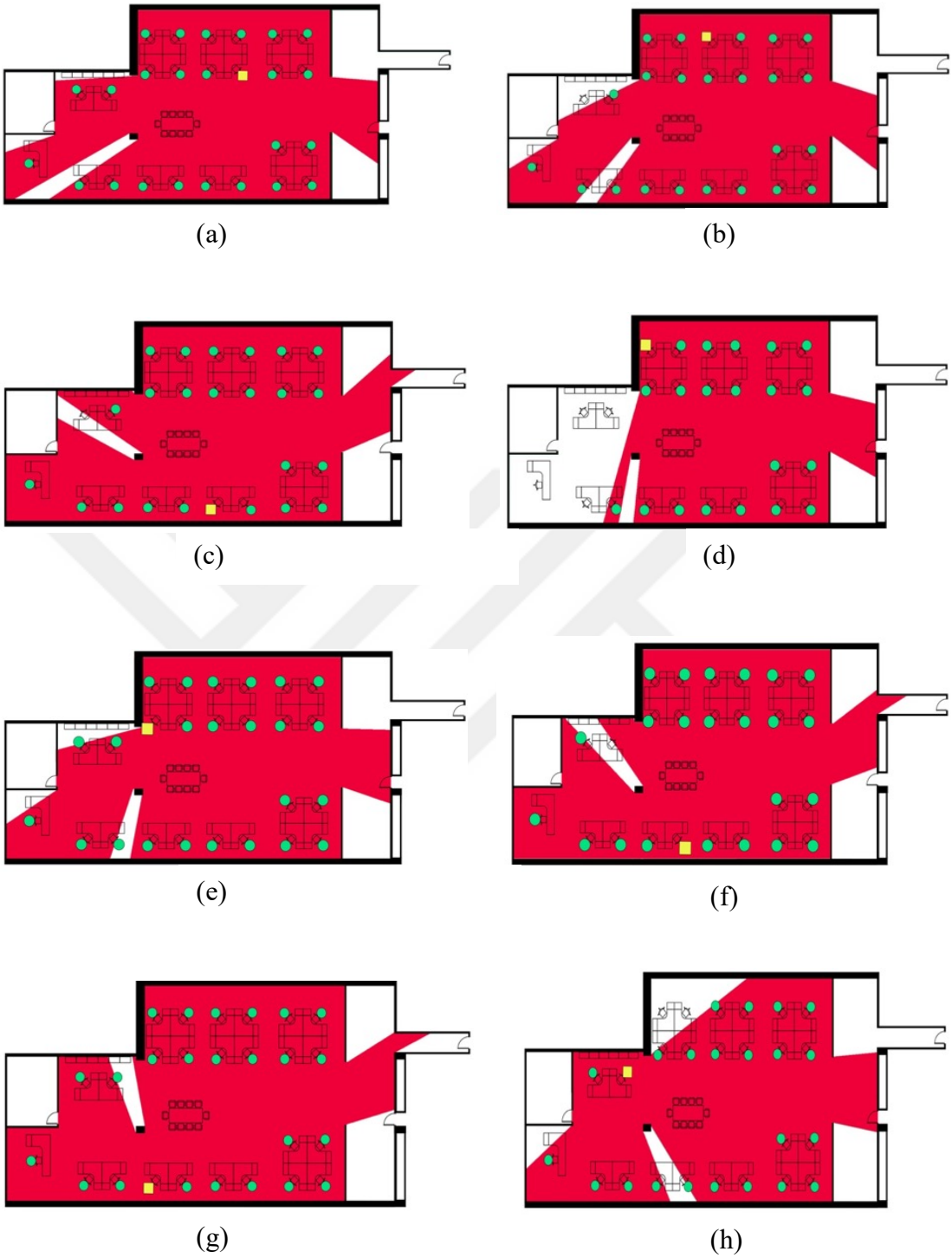


Figure 54. Density analyses for different desks of Tepe Home: (a) Desk 7, (b) Desk 8, (c) Desk 9, (d) Desk 10, (e) Desk 11, (f) Desk 12, (g) Desk 13, and (h) Desk 14

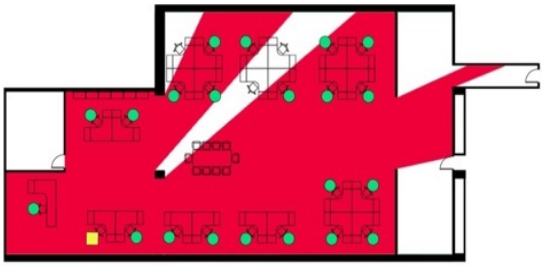


Figure 55. Density analysis for Desk 15 of Tepe Home

As seen in Figures 53, 54, and 55, 360° isovists were drawn for each desk. Following the isovist analysis, the area of each isovist was calculated through DepthMapX. Then, density was obtained by the ratio of the degree to the area (Table 17). Desk 10 had the highest density value, while all other desks in the office had the same density value.

Table 17. Density values of desks in Tepe Home

Desk Number	Area (360° isovist) (m^2)	Density
1	313.2690	0.07
2	325.3780	0.07
3	312.8850	0.07
4	317.1700	0.07
5	325.1020	0.07
6	308.0820	0.07
7	306.2430	0.07
8	297.5060	0.07
9	313.4150	0.07
10	246.3200	0.08
11	302.1240	0.07
12	312.1430	0.07
13	314.3690	0.07
14	285.1570	0.07
15	288.1060	0.07

4.2.2.2. Targeted Visibility Analysis Findings

The results were analyzed according to Outdegree, Binocular Density, and Targeted Visibility Analysis Tool.

Outdegree (n)

The number of directly visible employees sitting within the 120° forward-facing isovist was calculated, as seen in Figures 56, 57, and 58. Visible desks were indicated with green dots, while the selected desks were symbolized with a yellow square.

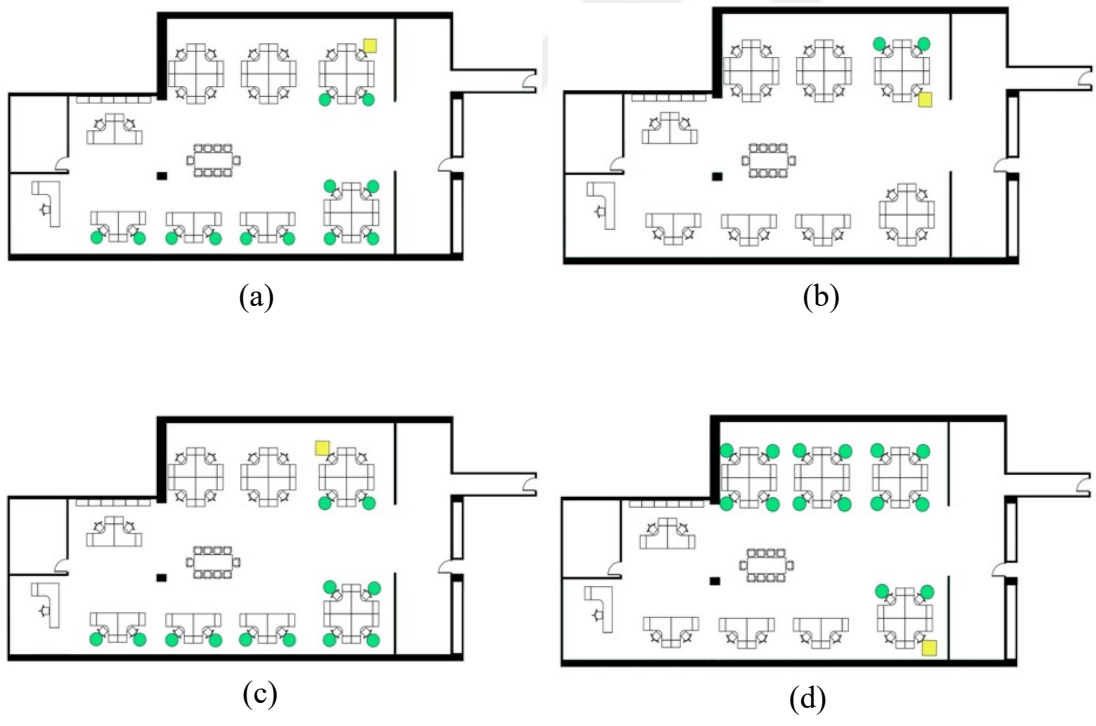


Figure 56. Outdegree analyses for different desks of Tepe Home: (a) Desk 1, (b) Desk 2, (c) Desk 3, and (d) Desk 4

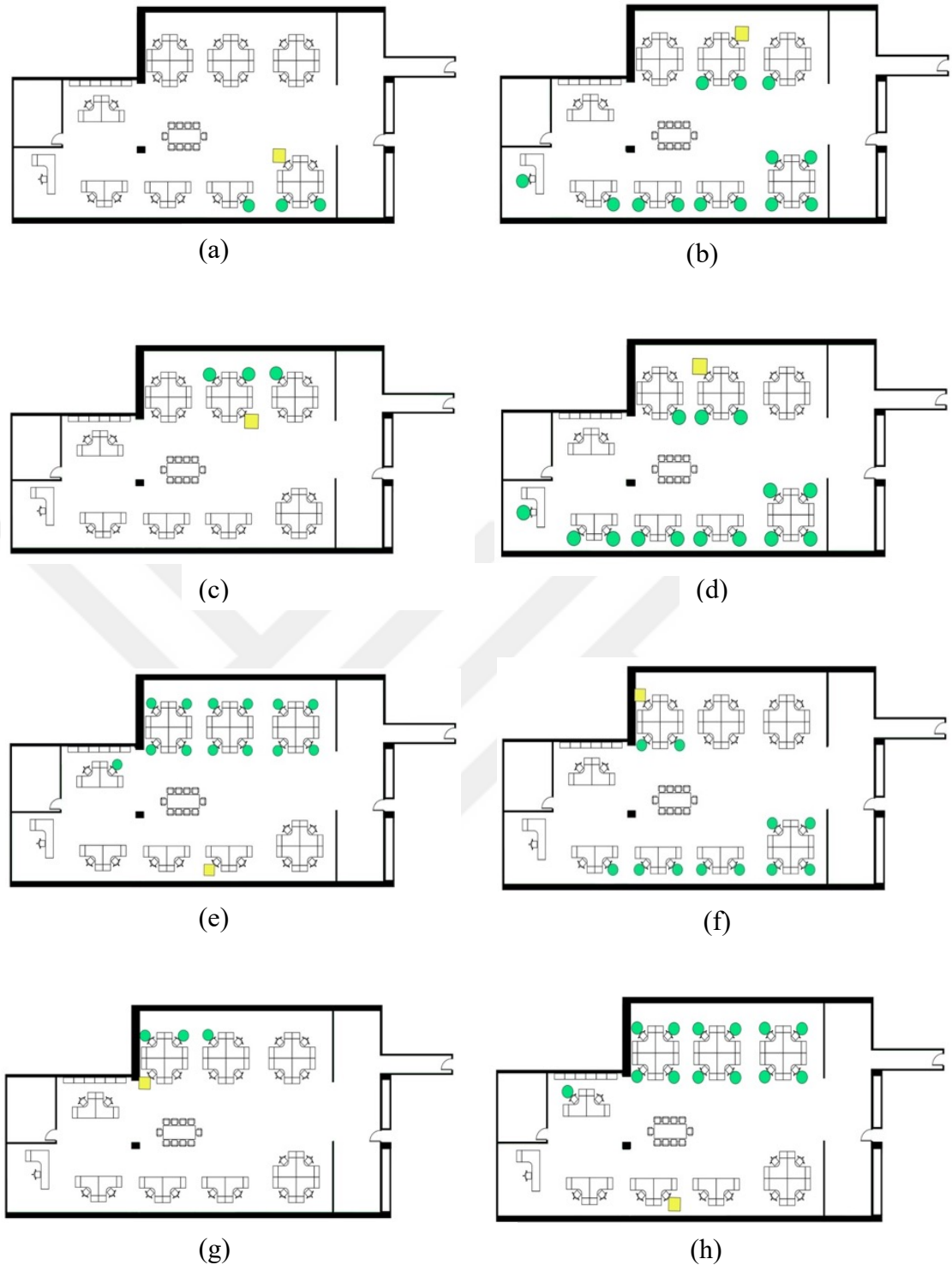
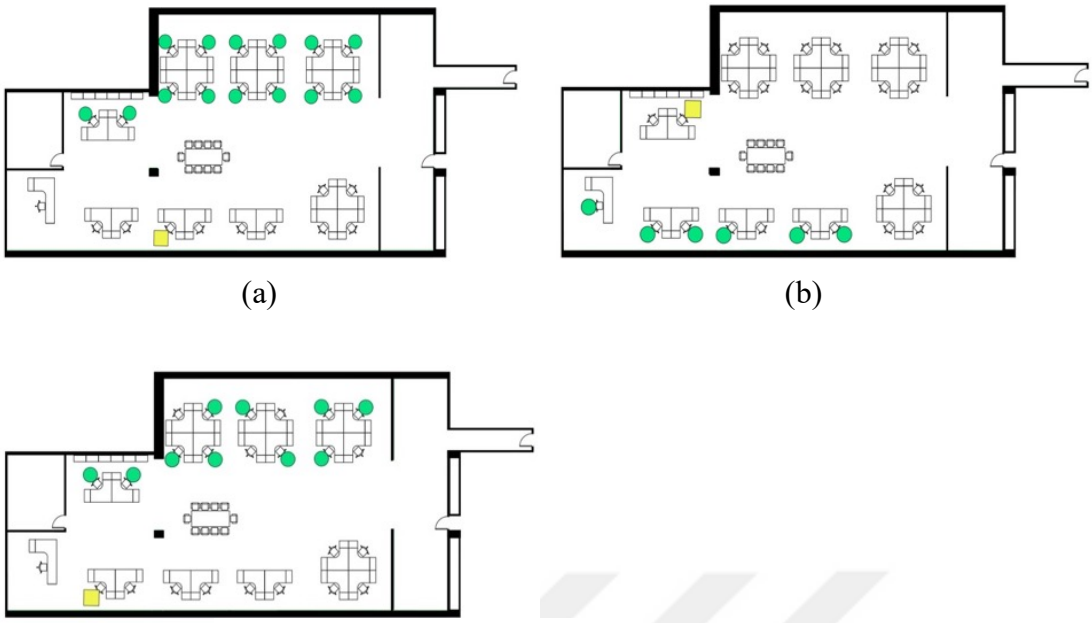


Figure 57. Outdegree analyses for different desks of Tepe Home: (a) Desk 5, (b) Desk 6, (c) Desk 7, (d) Desk 8, (e) Desk 9, (f) Desk 10, (g) Desk 11, and (h) Desk 12



(a) (b)

(c)

Figure 58. Outdegree analyses for different desks of Tepe Home: (a) Desk 13, (b) Desk 14, and (c) Desk 15

As seen in Figures 56, 57, and 58, the number of desks within the desks' 120° isovist was obtained. In addition to graphs, outdegree values were presented in Table 18. Desks 4, 8, and 13 had high outdegree values in the office, while desk 2 had the lowest outdegree value in the office. In other words, employees who sat and faced forward at desks 4, 8, and 13 had more visible employees sitting at their desks.

Table 18. Outdegree values of desks in Tepe Home

Desk Number	Outdegree (Unit: Number of desks)
1	12.00
2	2.00
3	12.00
4	14.00
5	3.00
6	13.00
7	3.00
8	14.00
9	13.00
10	11.00
11	3.00
12	13.00
13	14.00
14	6.00
15	10.00

Binocular Density (120°) (n/m²)

Binocular density was calculated by the ratio of the outdegree to the area of the 120° isovist. Partial isovist analysis for each workstation was conducted while employees faced forward.

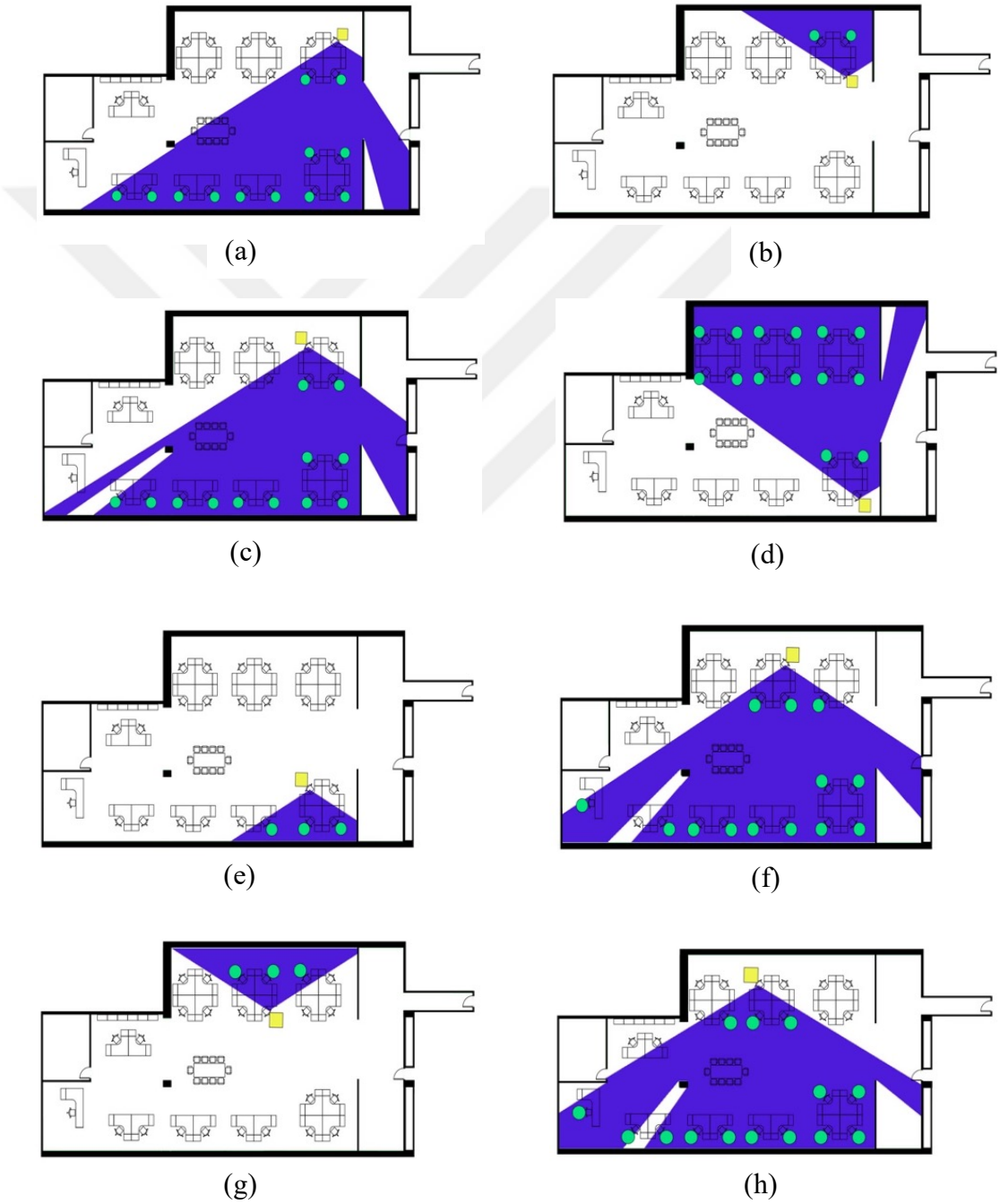


Figure 59. Binocular density analyses for different desks of Tepe Home: (a) Desk 1, (b) Desk 2, (c) Desk 3, (d) Desk 4, (e) Desk 5, (f) Desk 6, (g) Desk 7, and (h) Desk 8

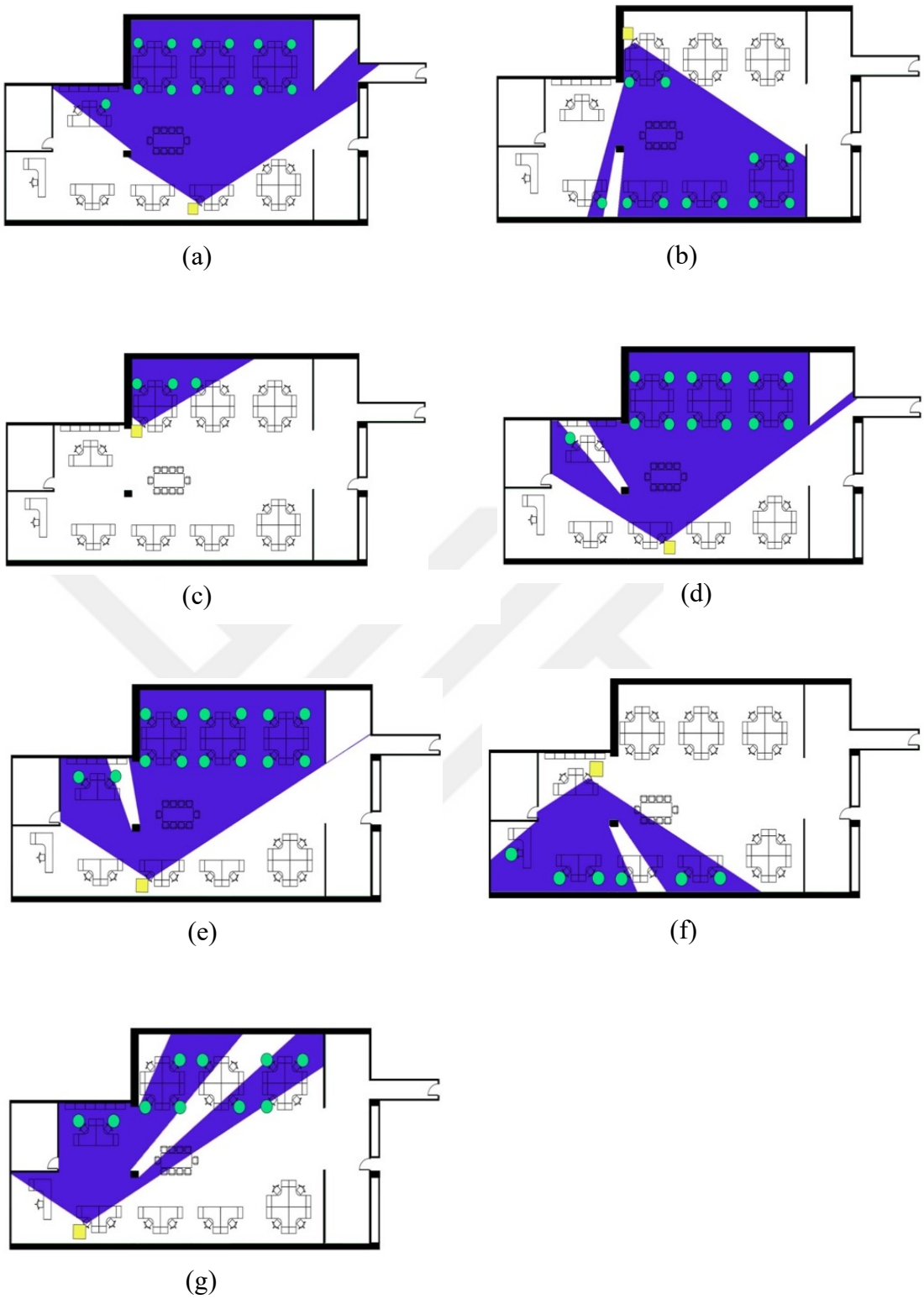


Figure 60. Binocular density analyses for different desks of Tepe Home: (a) Desk 9, (b) Desk 10, (c) Desk 11, (d) Desk 12, (e) Desk 13, (f) Desk 14, and (g) Desk 15

Figures 59 and 60 show that 120° isovists were drawn for each desk. Following the isovist analysis, the area of each isovist was calculated through DepthMapX. Then, binocular density was calculated by the ratio of the outdegree to the area (Table 19). Desk 5 had the highest binocular density value, while desks 1, 2, 3, 6, 8, 9, and 14 had lower binocular density values in the office.

Table 19. Binocular density values of desks in Tepe Home

Desk Number	Area (120° isovist) (m^2)	Binocular Density
1	174.2350	0.06
2	29.6746	0.06
3	193.1070	0.06
4	160.9570	0.08
5	21.7368	0.13
6	209.2090	0.06
7	35.6574	0.08
8	213.3560	0.06
9	197.4160	0.06
10	137.9080	0.07
11	26.7350	0.11
12	183.0160	0.07
13	170.7220	0.07
14	90.2884	0.06
15	118.8020	0.08

Targeted Visibility Analysis Tool

Targeted visibility analysis was undertaken to assess the visibility of specific visual elements (other employees sitting and walking) from each desk in the office and performed for each employee separately. Following the analysis, graphs, targeted visibility ratios of the 15 different desks, and the number of visible employees from these desks were obtained. Targeted visibility analysis was conducted for distances between walking and sitting targets. Social distance (150 cm) and personal distance (60 cm) were taken into consideration in order to understand if different distances affected targeted visibility values (Hall, 1969).

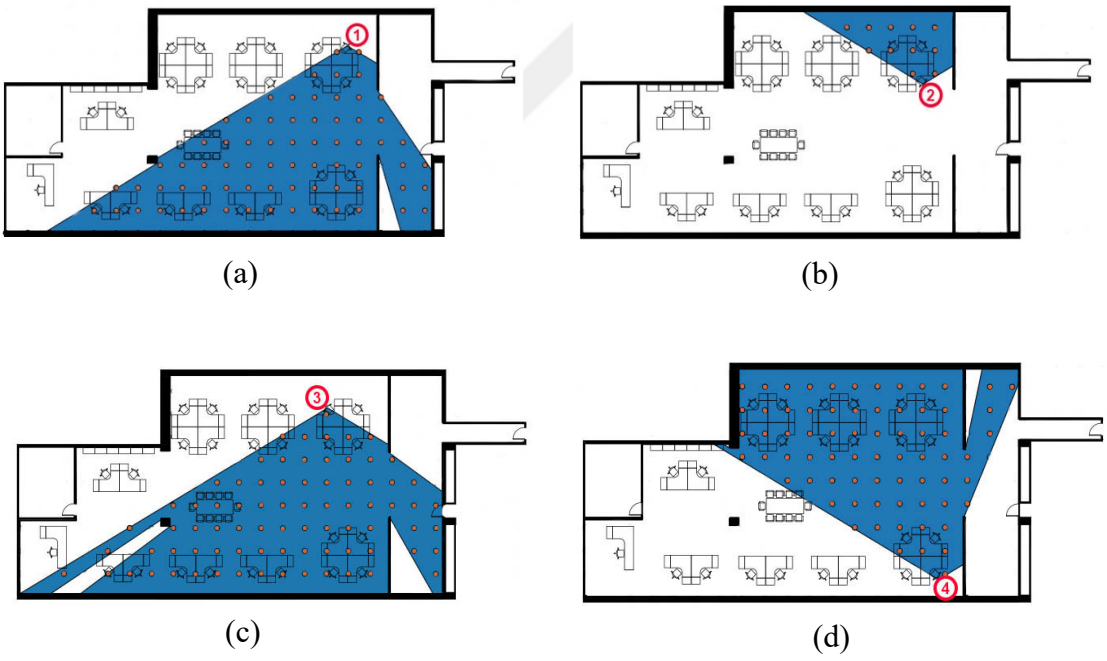


Figure 61. Targeted visibility analyses (150 cm) for different desks of Tepe Home: (a) Desk 1, (b) Desk 2, (c) Desk 3, and (d) Desk 4

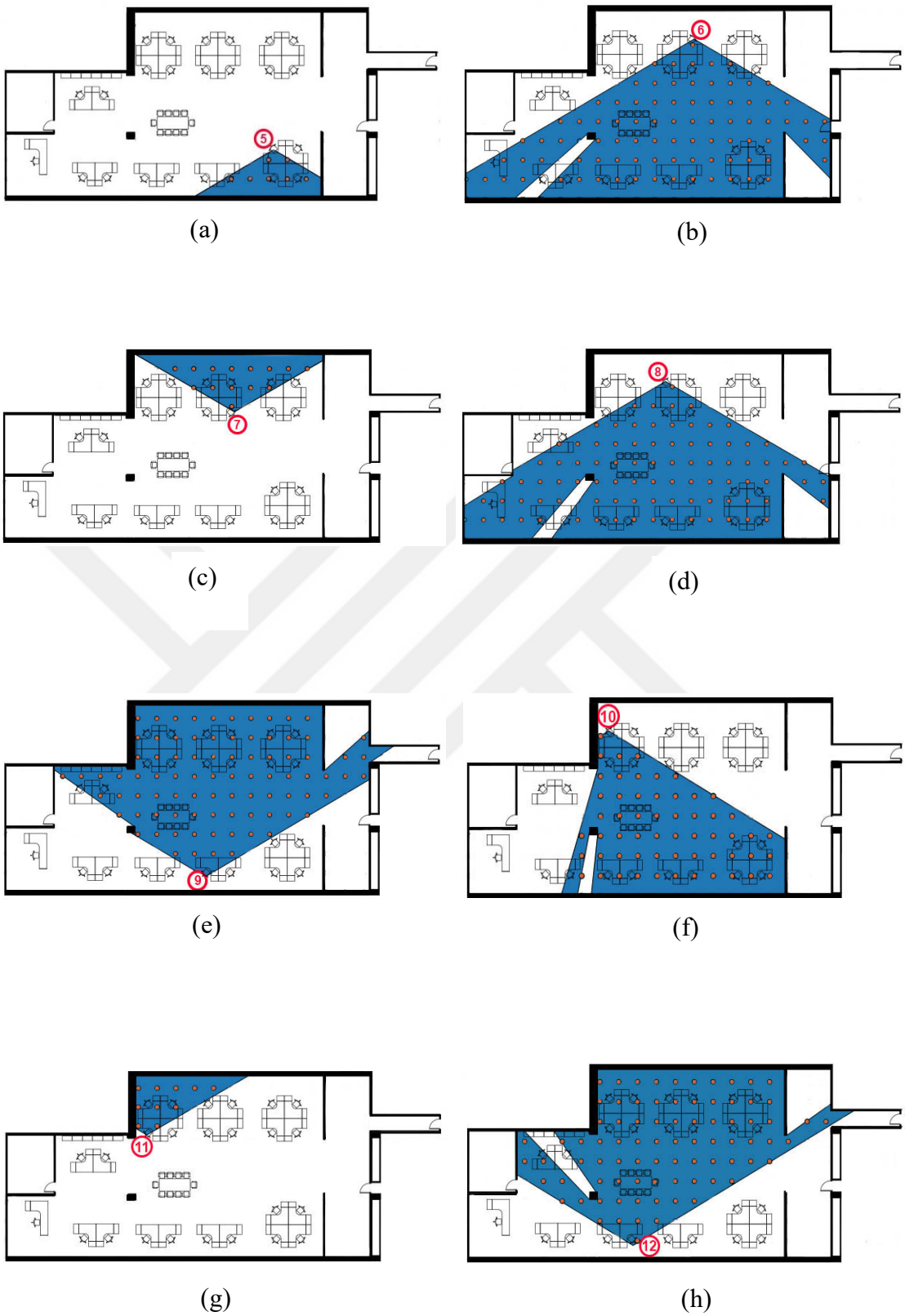
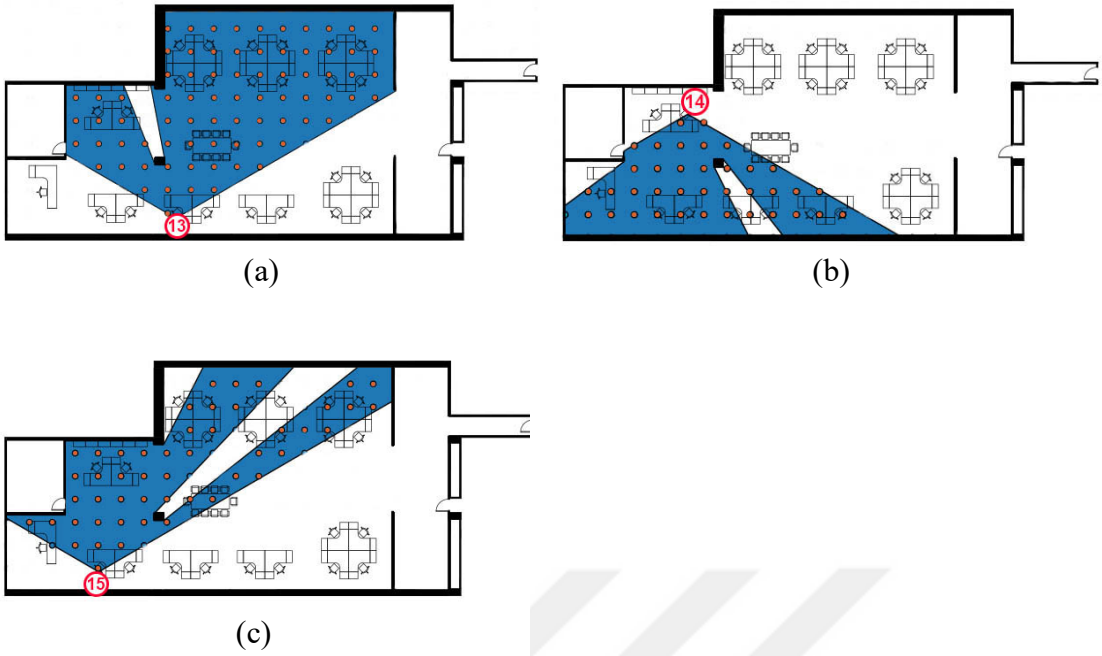


Figure 62. Targeted visibility analyses (150 cm) for different desks of Tepe Home: (a) Desk 5, (b) Desk 6, (c) Desk 7, (d) Desk 8, (e) Desk 9, (f) Desk 10, (g) Desk 11 and (h) Desk 12



(a) (b) (c)

Figure 63. Targeted visibility analyses (150 cm) for different desks of Tepe Home: (a) Desk 13, (b) Desk 14, and (c) Desk 15

As seen in Figures 61, 62, and 63, 15 graphs were obtained in order to perform the targeted visibility analysis for 150 cm distance. Isovist areas for each desk were indicated in blue on the graphs. In addition to the graphs, targeted visibility ratios and visible employees for 60 cm and 150 cm are shown in Table 20.

Based on the results of the targeted visibility analysis at a distance of 150 cm, desk 12 had the highest targeted visibility ratio compared to the other desks. In other words, the employee sitting at desk 12 is more likely to see other employees in the open-plan office when facing forward. When the number of visible employees from their desks increased, their visual privacy decreased. On the other hand, desk 5 had the lowest targeted visibility ratio. Moreover, according to targeted visibility analyses at a distance of 150 cm, the visual privacy level of employee sitting at desk

5 was higher than other employees when this employee faced forward. Based on the results of targeted visibility analysis at a distance of 60 cm, desk 4 had the highest targeted visibility ratio compared with the others. On the other hand, desk 11 had the lowest targeted visibility ratio at a distance of 60 cm.

Table 20. Results of targeted visibility analysis in Tepe Home

Desk Number	TVR (150 cm)	Visible Agents (150 cm)	TVR (60 cm)	Visible Agents (60 cm)
1	0.035	68	0.244	474
2	0.033	11	0.254	84
3	0.036	78	0.244	525
4	0.039	70	0.260	465
5	0.029	7	0.227	55
6	0.037	86	0.248	577
7	0.035	14	0.254	101
8	0.037	89	0.246	585
9	0.038	85	0.250	549
10	0.036	56	0.240	369
11	0.033	10	0.218	65
12	0.040	82	0.256	521
13	0.038	77	0.246	493
14	0.033	34	0.236	237
15	0.037	49	0.255	337

4.2.2.3. Survey Findings

Survey questions related to work-process interactions were analyzed through axial analysis. The outputs of the survey were both maps and tables. Other multiple-choice test questions of the survey were analyzed descriptively.

Work-Process Interaction Diagram and Connectivity Levels

In order to determine work-process interaction patterns in the office, axial analysis was conducted through DepthMap. Circulation lines were drawn to complete all circulation lines and connect desks indicated by employees in the survey.

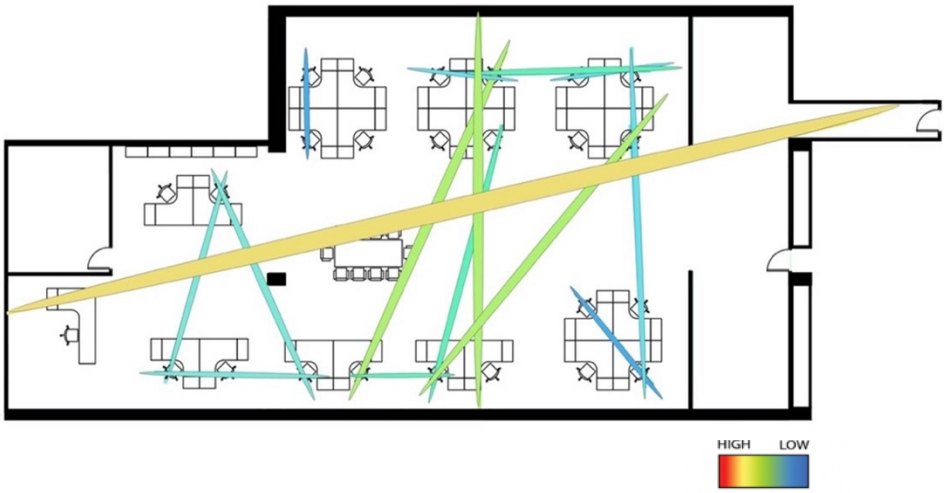


Figure 64. Work-process interaction diagram of Tepe Home

Circulation lines were evaluated according to their connectivity levels. As shown in Figure 64, the graph was obtained as a result of the connectivity values of circulation lines. Thicker lines demonstrate a higher integration in the open-plan office.

Integration affects the density of interaction in the setting (Grajewski, 1993). In addition to the graph, connectivity levels were also obtained numerically (Table 21). Connectivity values indicating the number of intersections each line makes with other lines were transferred to the SPSS for regression tests and correlation analysis.

Table 21. Connectivity levels through axial analysis in Tepe Home

Desk Number I	Desk Number II	Connectivity
1	2	3.33
2	9	4.66
3	1	2.00
4	2	2.50
5	4	1.00
6	1	4.00
7	9	4.00
8	6	3.00
9	12	4.33
10	11	1.00
11	10	1.00
12	6	4.00
13	15	2.50
14	13	3.00
15	14	2.50

Descriptive Analysis of Multiple-choice Test Questions

According to the answers of employees, characteristics of interactions are shown in Table 22. The duration of the indicated interaction is mostly between 1-10 minutes (n=7, 46.7%). The majority of the indicated interactions are with more than three employees (n=11, 73.3%). Indicated interactions are commonly planned interactions (n=8, 53.3%). Most employees interacted with their colleagues for work processes (n=9, 60%). The main reason for these work process interactions is an improvement (n=8, 53.3%). Mainly, interactions occur between employees in the same team (n=10, 66.7%).

Table 22. Interaction characteristics in Tepe Home (n=15) (Yenel Guler & Demirkan, 2022)

	Frequency	Percentage
Duration of the indicated interaction (minutes)		
1-10	7	46.7
11-20	2	13.3
21 minutes or more	6	40.0
The number of employees who take place in the indicated interaction		
Three or fewer employees	4	26.7
More than three employees	11	73.3
Organizing before the interaction		
Planned	8	53.3
Unplanned	7	46.7
The content of the interaction		
Work-process interaction	9	60.0
Social interaction	0	0
Both	6	40.0
The main reason to interact		
Expert advice	1	6.7
Improvement	8	53.3
Decision making	5	33.3
Innovation	1	6.7
The team of the employee who is interacted		
Same team	10	66.7
Different team	5	33.3

Eta Coefficient Test

Eta coefficient test is conducted to determine the strength of association between interaction characteristics (independent) and the number of work-process interactions (dependent) since interaction characteristics are categorical variables.

Table 23 presents the results of the Eta Coefficient tests. There was a significant association between the duration of interaction (1-10/11-20/21-30) and the number of work-process interactions ($\eta = 0.230$). It suggests a weak association between the variables. The duration of interaction attributes to 5% of the variance in work-process interactions ($\eta^2 = 0.05$).

There was a significant association between the number of employees in the indicated interaction (three or less/more than three) and the number of work-process interactions ($\eta = 0.052$). It suggests a negligible association between the variables. The number of employees interaction attributes to 0.2% of the variance in work-process interactions ($\eta^2 = 0.002$).

There was a significant association between planned/unplanned interaction and the number of work-process interactions ($\eta = 0.321$). It suggests a weak association between the variables. Planned/unplanned interaction attributes to 10% of the variance in work-process interactions ($\eta^2 = 0.10$).

There was a significant association between the content of interaction (work-process/social/both) and the number of work-process interactions ($\eta = 0.138$). It

suggests a negligible association between the variables. The content of interaction attributes to 1.9% of the variance in work-process interactions ($\eta^2 = 0.019$).

There was a significant association between the reasons for interaction (expert advice/improvement/decision-making) and the number of work-process interactions ($\eta = 0.526$). It suggests a moderate association between the variables. The reason for interaction attributes to 27% of the variance in work-process interactions ($\eta^2 = 0.27$).

There was a significant association between team type of interaction (same/different) and the number of work-process interactions ($\eta = 0.285$). It suggests a weak association between the variables. The team of interaction attributes to 8% of the variance in work-process interactions ($\eta^2 = 0.08$).

Table 23. Results of the Eta Coefficient test

Correlations	Eta Coefficients	Explained Variance (%)
Duration of Interaction vs. Number of Work-process Interactions	0.230	5
Number of Employees Interact vs. Number of Work-process Interactions	0.052	0.2
Planned/Unplanned Interaction vs. Number of Work-process Interactions	0.321	10
Content of Interaction vs. Number of Work-process Interactions	0.138	1.9
Reason of Interaction vs. Number of Work-process Interactions	0.526	27
Team Type of Interaction vs. Number of Work-process Interactions	0.285	8

4.2.3. Comparisons of the Results of Two Offices

Degree, density, visual integration, outdegree, binocular density, TVR – social distance, and TVR – personal distance values obtained from both open-plan offices of Öncüoğlu Architects and Tepe Home were combined in order to evaluate differences and similarities between offices in the Discussion Part (Table 24).

Table 24. Combined results of Öncüoğlu Architects and Tepe Home

Desk No.	Degree		Density		Visual Integration		Outdegree		Binocular Density		TVR-Personal Distance		TVR-Social Distance	
	O.A.	T.H.	O.A.	T.H.	O.A.	T.H.	O.A.	T.H.	O.A.	T.H.	O.A.	T.H.	O.A.	T.H.
1	8	24	0.09	0.07	18.00	57.17	6	12	0.09	0.06	0.248	0.244	0.040	0.035
2	11	24	0.14	0.07	17.32	70.32	9	2	0.16	0.06	0.249	0.254	0.035	0.033
3	17	24	0.15	0.07	20.63	58.13	11	12	0.21	0.06	0.255	0.244	0.035	0.036
4	10	24	0.15	0.07	9.00	69.93	8	14	0.16	0.08	0.253	0.260	0.031	0.039
5	12	24	0.17	0.07	9.81	86.54	3	3	0.16	0.13	0.252	0.227	0.034	0.029
6	21	22	0.15	0.07	26.28	55.17	0	13	0	0.06	0.000	0.248	0.000	0.037
7	27	24	0.19	0.07	25.71	58.86	14	3	0.26	0.08	0.252	0.254	0.040	0.035
8	18	23	0.21	0.07	9.84	51.78	8	14	0.23	0.06	0.256	0.246	0.043	0.037
9	22	23	0.21	0.07	12.11	71.65	9	13	0.24	0.06	0.259	0.250	0.041	0.038
10	24	20	0.21	0.08	12.88	29.52	8	11	0.23	0.07	0.252	0.240	0.042	0.036
11	18	24	0.22	0.07	9.44	51.92	9	3	0.22	0.11	0.251	0.218	0.037	0.033
12	20	23	0.21	0.07	10.19	69.68	11	13	0.20	0.07	0.234	0.256	0.031	0.040
13	19	24	0.22	0.07	9.96	72.75	3	14	0.18	0.07	0.278	0.246	0.050	0.038
14	17	22	0.21	0.07	9.49	42.25	15	6	0.24	0.06	0.250	0.236	0.037	0.033
15	19	21	0.22	0.07	9.87	46.79	16	10	0.24	0.08	0.240	0.255	0.033	0.037

O.A.: Öncüoğlu Architects
T.H.: Tepe Home

Values obtained from two open-plan offices were categorized according to parameters and compared through graphs. Figure 65 represents two offices' generic visibility parameters (degree, density, and visual integration). Degree values of two open-plan offices are very similar when desks 1, 2, 3, 4, and 5 in Öncüoğlu Architects were ignored (Figure 65a). These desks were located in the small wing of the L-shaped plan layout of this office. The rest of the building has a more compact floor plan with a rectangular layout like the Tepe Home office. Moreover, as Figure 65b shows, the density values of the two open-plan offices are explicitly different because density values in the office of the Tepe Home do not change from one desk to another as a result of the compact floor plan. Furthermore, although fluctuations in the graph representing the visual integration levels are similar, the office of Tepe Home is visually more integrated than the office of Öncüoğlu Architects (Figure 65c).

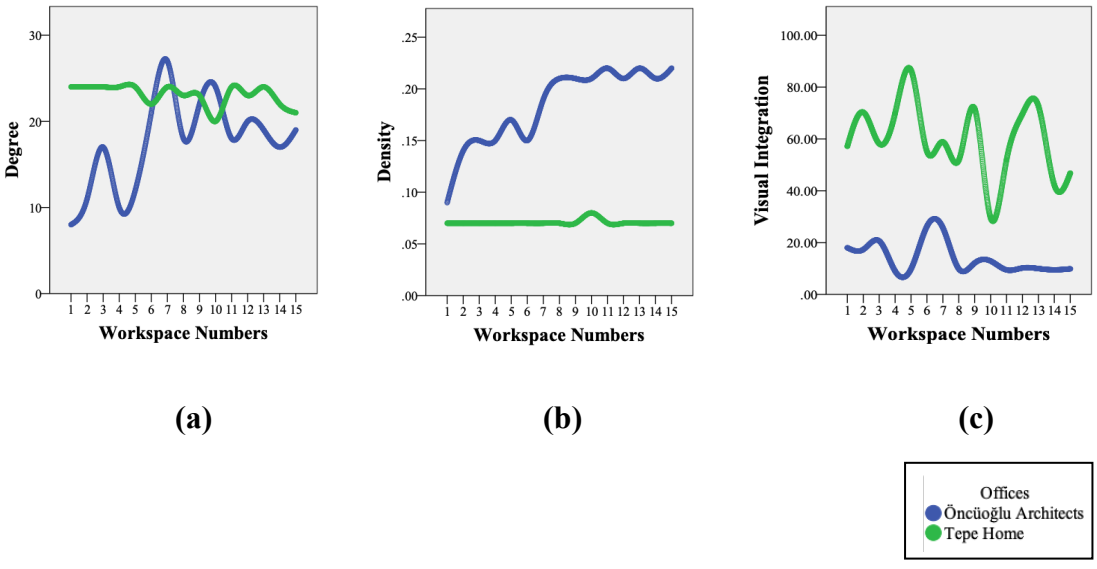


Figure 65. Generic visibility parameters in two open-plan offices: (a) Degree values, (b) Density values, (c) Visual Integration values

Figure 66 represents two offices' targeted visibility parameters (outdegree, binocular density, TVR-social distance, and TVR- personal distance). As desk 6 in the office of Öncüoğlu Architects is located across the wall, all targeted visibility values for desk 6 in Öncüoğlu Architects are zero. Therefore, as this data is an outlier, targeted visibility data of desk 6 in the office of Öncüoğlu Architects were removed from the datasets for further statistical analysis.

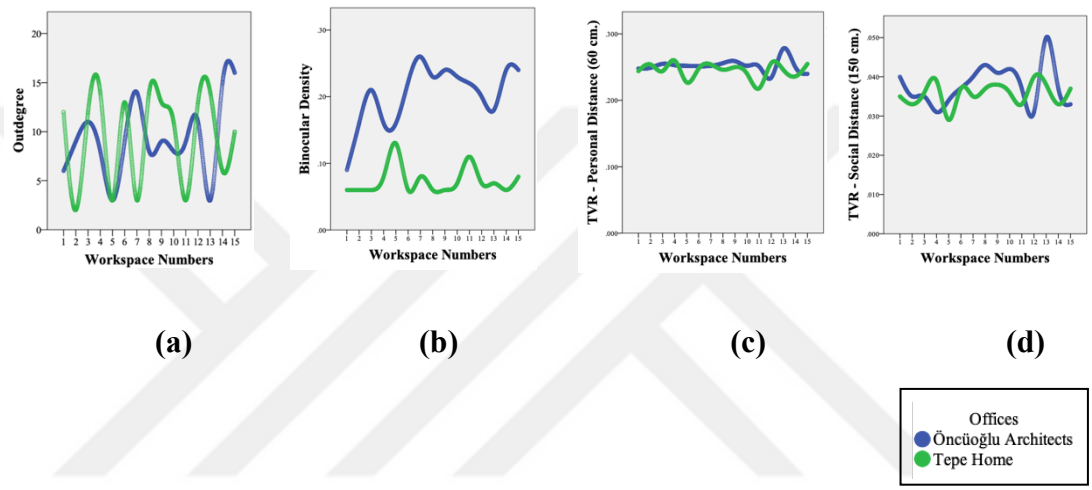


Figure 66. Targeted visibility parameters in two open-plan offices: (a) Outdegree, (b) Binocular density, (c) TVR – Personal distance, (d) TVR – Social Distance

4.2.3.1 Bootstrapped Pearson Correlation Analysis

In order to find the sampling distribution of each statistic, bootstrapped correlation analysis was performed. Bootstrapped Pearson correlation analysis was used to measure the relationship between the study variables with 1000 bootstrap samples. Pearson's correlation coefficient (r) measures the strength and direction of association between these variables.

Öncüoğlu Architects

The correlations between the dependent variable (work-process interactions) and independent variables (degree, density, visual integration, outdegree, binocular density, and targeted visibility ratio) were measured in order to understand how these parameters influence work-process interactions in open-plan offices. The results of the correlation analysis are presented in Table 25. The correlation coefficients (r) between the dependent and independent variables are represented in the last column of the correlation table. No correlation was found between work-process interaction and visual integration, outdegree, and TVRs (60 and 150 cm). According to the results, when the degree of the employees' desks increases, the work-process interaction decreases (-0.544, $p<0.05$). Moreover, when the density of desks at which employees work increases, their work-process interactions decrease (-0.835, $p<0.01$). Furthermore, if the binocular density of employees' desks increases, the work-process interaction decreases (-0.639, $p<0.05$). These analyses mean that when employees see more people sitting in their visible area (both 120° and 360° isovist), they avoid interacting while working in the open-plan office.

Table 25. Bootstrapped correlations between work-process interactions for Öncüoğlu Architects (n=1000)

			GENERIC VISIBILITY			TARGETED VISIBILITY				Work-process Inter.
			Deg.	**Dens.**	**Visual Integ.**	**Outdeg.**	**Bin. Dens.**	**TVR (60 cm)**	**TVR (150 cm)**	
GENERIC VISIBILITY	**Deg.**	PCC (r)	1	0.737**	0.182	0.407	0.857**	0.085	0.350	**-0.544***
		Sig. (2-tailed)		0.003	0.534	0.149	0.000	0.773	0.220	0.044
		N	14	14	14	14	14	14	14	14
	Dens.	PCC (r)	0.737**	1	-0.480	0.269	0.796**	0.119	0.249	**-0.835****
		Sig. (2-tailed)	0.003		0.083	0.352	0.001	0.685	0.391	0.000
		N	14	14	14	14	14	14	14	14
	Visual Integ.	PCC (r)	0.182	-0.480	1	0.223	-0.003	-0.020	0.078	0.444
		Sig. (2-tailed)	0.534	0.083		0.444	0.992	0.945	0.791	0.112
		N	14	14	14	14	14	14	14	14
TARGETED VISIBILITY	**Outdeg.**	PCC (r)	0.407	0.269	0.223	1	0.635*	-0.550*	-0.395	-0.129
		Sig. (2-tailed)	0.149	0.352	0.444		0.015	0.042	0.163	0.661
		N	14	14	14	14	14	14	14	14
	Bin. Dens.	PCC (r)	0.857**	0.796*	-0.003	0.635*	1	-0.026	0.102	**-0.639***
		Sig. (2-tailed)	0.000	0.001	0.992	0.015		0.931	0.728	0.014
		N	14	14	14	14	14	14	14	14
	TVR – Personal Distance (60 cm)	PCC (r)	0.085	0.119	-0.020	-0.550*	-0.026	1	0.786**	-0.319
		Sig. (2-tailed)	0.773	0.685	0.945	0.042	0.931		0.001	0.267
		N	14	14	14	14	14	14	14	14
	TVR – Social Distance (150 cm)	PCC (r)	0.350	0.249	0.078	-0.395	0.102	0.786*	1	-0.171
		Sig. (2-tailed)	0.220	0.391	0.791	0.163	0.728	0.001		0.559
		N	14	14	14	14	14	14	14	14

**. Correlation is significant at the 0.01 level (2-tailed).

*. Correlation is significant at the 0.05 level (2-tailed).

Note. Deg. = Degree, Dens. = Density, Visual Integ. = Visual Integration, Outdeg. = Outdegree, Bin. Dens. = Binocular Density, TVR = Targeted Visibility Ratio, Work-process Inter. = Work-process Interactions, PCC = Pearson correlation coefficient.

Tepe Home

The correlations between the dependent variable (work-process interactions) and independent variables (degree, density, visual integration, outdegree, binocular density, and targeted visibility ratio) were measured in order to understand how these parameters influence work-process interactions in open-plan offices. The results of the correlation analysis are presented in Table 26. The correlation coefficients (r) between the dependent and independent variables are represented in the last column of the correlation table. No correlation was found between work-process interaction and degree, density, visual integration, outdegree, and TVR (150 cm). According to the results, when the binocular density of the employees' desks increases, the work-process interaction decreases (-0.634, $p<0.05$). If employees face forward and see more colleagues sitting in their visible area (120° isovist), they avoid interacting with others while working in the open-plan office. Moreover, when the TVR (60 cm) of the employee's desks increases, their work-process interactions increase as well (0.681, $p<0.01$). If employees face forward and see more colleagues sitting and walking in their visible area (120° isovist), they interact more with their colleagues.

Table 26. Bootstrapped correlations between work-process interactions for Tepe Home (n=1000)

			GENERIC VISIBILITY			TARGETED VISIBILITY				
			Deg.	**Dens.**	**Visual Integ.**	**Outdeg.**	**Bin. Dens.**	**TVR (60 cm)**	**TVR (150 cm)**	**Work-process Inter.**
GENERIC VISIBILITY	**Deg.**	PCC (r)	1	-0.663**	0.725**	-0.221	0.233	-0.060	-0.191	0.143
		Sig. (2-tailed)		0.007	0.002	0.429	0.404	0.832	0.495	0.612
		N	15	15	15	15	15	15	15	15
	Dens.	PCC (r)	-0.663**	1	-0.578*	0.087	-0.054	-0.127	0.026	-0.418
		Sig. (2-tailed)	0.007		0.024	0.759	0.849	0.653	0.927	0.121
		N	15	15	15	15	15	15	15	15
	Visual Integ.	PCC (r)	0.725**	-0.578*	1	-0.073	0.335	0.137	-0.081	0.225
		Sig. (2-tailed)	0.002	0.024		0.796	0.222	0.626	0.774	0.420
		N	15	15	15	15	15	15	15	15
TARGETED VISIBILITY	**Outdeg.**	PCC (r)	-0.221	0.087	-0.073	1	-0.533*	0.447	0.827	0.116
		Sig. (2-tailed)	0.429	0.759	0.796		0.041	0.094	0.000	0.680
		N	15	15	15	15	15	15	15	15
	Bin. Dens.	PCC (r)	0.233	-0.054	0.335	-0.533*	1	-0.580*	-0.566*	**-0.634***
		Sig. (2-tailed)	0.404	0.849	0.222	0.041		0.023	0.028	0.011
		N	15	15	15	15	15	15	15	15
	TVR – Personal Distance (60 cm)	PCC (r)	-0.060	-0.127	0.137	0.447	-0.580*	1	0.697**	**0.681****
		Sig. (2-tailed)	0.832	0.653	0.626	0.094	0.023		0.004	0.267
		N	15	15	15	15	15	15	15	15
	TVR – Social Distance (150 cm)	PCC (r)	-0.191	0.026	-0.081	0.827**	-0.566*	0.697**	1	0.364
		Sig. (2-tailed)	0.495	0.927	0.774	0.000	0.028	0.004		0.182
		N	15	15	15	15	15	15	15	15

**. Correlation is significant at the 0.01 level (2-tailed).

*. Correlation is significant at the 0.05 level (2-tailed).

Note. Deg. = Degree, Dens. = Density, Visual Integ. = Visual Integration, Outdeg. = Outdegree, Bin. Dens. = Binocular Density, TVR = Targeted Visibility Ratio, Work-process Inter. = Work-process Interactions, PCC = Pearson correlation coefficient.

4.2.3.2. Multiple Regression Analysis

Multiple regression analysis was conducted in order to analyze the relationship between the independent variables and the dependent variable of the study. Regression analyses were conducted separately for generic visibility parameters and targeted visibility parameters. For the regression analysis between generic visibility, and work-process interactions, degree, density, and visual integration are the independent variables, while work-process interaction is the dependent variable. On the other hand, for the regression analysis between targeted visibility and work-process interactions, outdegree, binocular density, and TVRs (60 cm and 150 cm) are the independent variables, while work-process interaction is the dependent variable.

Öncüoğlu Architects

Based on regression analysis between generic visibility and work-process interactions, there is a statistically significant regression between density (independent) and work-process interaction (dependent) (see Table 27). Density is negatively correlated with work-process interactions (β=-1.417, SE=28.68, $p<0.05$). Work-process interactions increase when the density (β=-1.417) decreases. Other correlated independent variables (degree and visual integration) are not included in the regression model as they do not bring statistically significant information to the model.

Table 27. Regression coefficients for generic visibility (Öncüoğlu Architects)

Constant	Const. B	B	β	t-Ratio	Sig.
Degree		0.176	0.533	0.938	0.368
Density	17.935	-63.237	-1.417	-2.205	0.050
Visual Integration		-0.134	-0.460	-0.925	0.375

Note: Const. B = Constant Regression Coefficient, B = Regression Coefficient, β = Standardized Coefficient, Sig. = Significant Ratio.

According to regression analysis between targeted visibility and work-process interactions, there is a statistically significant regression between binocular density (independent) and work-process interaction (dependent) (see Table 28). Binocular density is negatively correlated with work-process interactions (β=-0.936, SE=12.15, $p<0.014$). Work-process interactions increase when the binocular density (β=-0.936) decreases. Other correlated independent variables (outdegree and TVRs (60 cm and 150 cm)) are not included in the regression model as they do not bring statistically significant information to the model.

Table 28. Regression coefficients for targeted visibility (Öncüoğlu Architects)

Constant	Const. B	B	β	t-Ratio	Sig.
Outdegree		0.172	0.372	1.021	0.334
Binocular Density		-36.718	-0.936	-3.022	0.014
	30.941				
TVR 60		-94.270	-0.508	-1.370	0.204
TVR 150		162.539	0.470	1.400	0.195

Note: Const. B = Constant Regression Coefficient, B = Regression Coefficient, β = Standardized Coefficient, Sig. = Significant Ratio.

Tepe Home

According to regression analysis between generic visibility and work-process interactions, the relationship between the dependent variable and independent variables is not statistically significant (Table 29).

Table 29. Regression coefficients for generic visibility (Tepe Home)

Constant	Const. B	B	β	t-Ratio	Sig.
Degree		-0.314	-0.328	-0.762	0.462
Density	27.923	-262.535	-0.553	-1.523	0.156
Visual Integration		0.012	0.144	0.364	0.723

Note: Const. B = Constant Regression Coefficient, B = Regression Coefficient, β = Standardized Coefficient, Sig. = Significant Ratio.

According to regression analysis between targeted visibility and work-process interactions, there is a statistically significant regression between binocular density (independent) and work-process interaction (dependent) (Table 30). Binocular density is negatively correlated with work-process interactions (β=-0.535, SE=14.30, $p<0.05$). Work-process interactions increase when the binocular density (β=-0.535) decreases. Other correlated independent variables (outdegree and TVRs (60 cm and 150 cm)) are not included in the regression model as they do not bring statistically significant information to the model.

Table 30. Regression coefficients for targeted visibility (Tepe Home)

Constant	Const. B	B	β	t-Ratio	Sig.
Outdegree		-0.127	-0.485	-1.373	0.200
Binocular density		-31.788	-0.535	-2.223	0.050
	-8.835				
TVR 60		55.671	0.515	1.781	0.105
TVR 150		44.807	0.104	0.244	0.812

Note: Const. B = Constant Regression Coefficient, B = Regression Coefficient, β = Standardized Coefficient, Sig. = Significant Ratio.

According to regression analysis for Öncüoğlu Architects, density and binocular density are negatively correlated with work-process interactions. On the other hand, binocular density is negatively correlated with work-process interactions based on regression analysis for Tepe Home. The summary of regression coefficients is represented in Table 31.

Table 31. Summary of regression coefficients

	Constant	Constant. B	B	β	t-Ratio	Sig.
ONCUOGLU ARCHITECTS	**Density**	17.935	-63.237	-1.417	-2.205	0.050
	Binocular Density	30.941	-36.718	-0.936	-3.022	0.014
TEPE HOME	**Binocular Density**	-8.835	-31.788	-0.535	-2.223	0.050

The results are discussed in the next chapter. First, qualitative findings regarding visual privacy, crowding, personal space, and territoriality are discussed. Then, quantitative findings are discussed under six different concepts of visibility: degree, density, visual integration, outdegree, binocular density, and targeted visibility ratio.

CHAPTER 5

DISCUSSION

Obtained qualitative and quantitative results are discussed in two parts. First, open-ended questions of the survey are examined to detect employee perceptions of open-plan offices. Second, visibility analyses are evaluated to understand the impacts of targeted and generic visibility on work-process interactions.

5.1. Discussion on Qualitative Findings

This study confirmed that the lack of visual privacy is still an unsolved problem in open-plan offices. Employees prefer private offices to open-plan offices because seeing other colleagues and being visible makes them uncomfortable (Sundstrom et al., 1982b). Inadequate or missing visual barriers between desks make them feel under pressure when they cannot complete a work task. Moreover, employees evaluate visual privacy levels of desks in open-plan offices according to desk allocation and think all employees have different levels of visual privacy in the same open-plan office. Thus, employees prefer desks far away from walkways or behind columns (Sailer et al., 2021).

Employees cannot focus on the task and feel uncomfortable when they see other colleagues in open-plan offices. They have to experience crowding in their offices as the number of employees around them increases (Altman, 1975; Saegert, 1978; Stokols, 1972). Thus, employees are frequently distracted while working in open-plan offices and interrupted at work by their colleagues as they do not have any visual control over their space (Block & Stokes, 1989). Moreover, employees are willing to have adequate personal space while working in open-plan offices. They evaluate having control over their desks as one of the most important factors for their productivity and motivation. Employees become uncomfortable when other colleagues use their personal belongings on their desks because of inadequate enclosure in open-plan offices. Thus, employees tend to exhibit territorial behaviors around their desks (Ayoko & Härtel, 2003).

Qualitative findings of this thesis revealed that most employees are dissatisfied with open-plan offices due to poor visual privacy, increased distraction, and inadequate personal space. On the other hand, according to some employees, the only advantage of working in open-plan offices is interaction. These employees are willing to interact with their colleagues for work processes and social purposes because they believe interaction increases their productivity at work. Therefore, they prefer to work in an open-plan office that enables them to interact with their colleagues while they have visual control over their desks.

5.2. Discussion on Quantitative Findings

Obtained results are discussed according to the stated hypotheses of the study. They are discussed under six different concepts: 1) degree, 2) density, 3) visual integration, 4) outdegree, 5) binocular density, and 6) targeted visibility ratio. Table 32 represents whether the hypotheses of the study are accepted or rejected.

Table 32. Summary of accepted and rejected hypotheses

Hypothesis	Reason	Result	Decision
H1	Higher degree	Less number of work-process interactions	Rejected
H2	Higher density	Less number of work-process interactions	Accepted
H3	Higher visual integration	Higher number of work-process interactions	Rejected
H4	Higher outdegree	Less number of work-process interactions	Rejected
H5	Higher binocular density	Less number of work-process interactions	Accepted
H6	Higher targeted visibility ratio	Less number of work-process interactions	Rejected

Hypothesis 1 (H1) suggested a negative correlation between the degree and the number of work-process interactions. However, the regression analyses revealed no significant association between the degree and work-process interactions within open-plan offices. The findings indicate that increasing the number of employees

within the 360° isovist area (higher degree) does not impact the number of work-process interactions in such office settings. H1 is rejected due to its lack of statistical significance, which may stem from the differing spatial characteristics of the two offices. The spatial layout of a building can influence the number of encounters within it, potentially leading to increased encounters in buildings with integrated plan layouts (Hillier et al. 1987). In sum, it suggests that the spatial layout of an office can shape the level of interpersonal encounters that occur within it. Consequently, the open-plan office of Tepe Home exhibits a more integrated plan layout, as evidenced by its higher visual integration value (M=54.99) compared to the fragmented plan layout of Öncüoğlu Architects (M=13.13). Furthermore, as depicted in Figure 67, the degree values of the two open-plan offices are similar when excluding desks 1, 2, 3, 4, and 5 in Öncüoğlu Architects, which are situated in the small wing of its L-shaped layout. The remaining portion of the building features a more compact, rectangular floor plan akin to that of the Tepe Home office. Consequently, variations in degree values arise from the distinct plan layouts of the two open-plan offices, ultimately leading to an insignificant relationship between degree and work-process interactions.

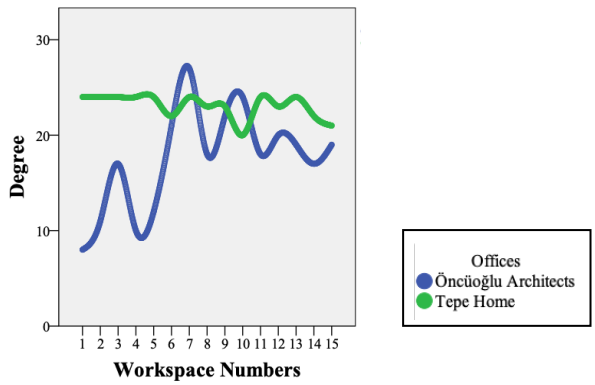


Figure 67. Degree values in two open-plan offices

Hypothesis 2 (H2) suggested a negative correlation between density and the number of work-process interactions. A negative relationship was found between density and work-process interactions in the regression analysis conducted for Öncüoğlu Architects' office (β=-1.41, SE=28.68, $p<0.05$). The regression results indicated that a higher ratio of visible employees to the area of the 360° isovist (reflecting higher density) led to fewer work-process interactions in the open-plan office. Conversely, regression analysis of Tepe Home office data showed no significant relationship between density and work-process interactions. The density values of the two open-plan offices differ entirely due to the Tepe Home office's consistent density values across desks, a characteristic stemming from its compact floor plan, as illustrated in Figure 68.

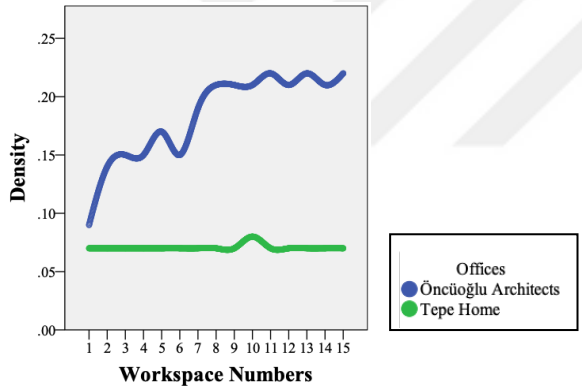


Figure 68. Density values in two open-plan offices

The differing density values between the two offices stem from their distinct plan shapes. Öncüoğlu Architects' office has a fragmented floor plan with a wing shape layout (L-shape), whereas Tepe Home's office features a more compact rectangular layout. As per findings by Shpuza et al. (2008), offices with less fragmented floor plans, like close blocks, tend to be more integrated, while those with higher fragmentation, like wing shapes (L-shape), are less integrated. Therefore, with its

compact floor plan, the Tepe Home office exhibits higher integration than the Öncüoğlu Architects' office, which has a fragmented wing shape layout. Furthermore, due to its highly integrated plan layout, Tepe Home's office has same density values for 14 out of 15 desks. Since density values do not vary between desks, no discernible relationship was found between density and work-process interactions in the Tepe Home's office. Thus, the findings from Öncüoğlu Architects' office support the assumption regarding density in open-plan offices. Hypothesis 2 (H2), suggesting a negative correlation between density and the number of work-process interactions, is accepted.

Hypothesis 3 (H3) suggested a positive correlation between visual integration and the number of work process interactions. However, based on the regression analysis results, no significant relationship was found between visual integration and the number of work-process interactions within open-plan offices. In sum, as indicated by the results of this study, desks with higher visual integration values do not necessarily facilitate a high level of interaction. Consequently, H3 is rejected due to its lack of significance. These findings challenge the assertions made by Hillier and Grajewski (1990), who suggested that more integrated offices lead to increased work-process interaction. Similarly, a separate study conducted by Sailer et al. (2016) using the Space Syntax methodology to measure employee interaction found that visually more integrated offices facilitate increased interaction. These contradictions with the results of the current study likely stem from the utilization of different Space Syntax measurements in the DepthmapX for integration calculations. Specifically, Hillier and Grajewski (1990) employed Axial Analysis, while Sailer et al. (2016) used Mean Depth, whereas this study utilized Visual Integration for its

analysis. However, the outcomes of this research align with the conclusions drawn by Steen and Markhede (2010), who employed space syntax techniques (Visibility Graph Analysis) to examine the correlation between spatial layout and social configurations within office environments. The results of this study are consistent with those of Steen and Markhede (2010), indicating no correlation between integration values and interactions in open-plan office settings.

Hypothesis 4 (H4) suggested a negative correlation between outdegree and the number of work-process interactions. However, based on the regression analysis findings, no significant relationship was found between outdegree values and the number of work-process interactions within both open-plan office settings. Put differently, the study results indicate that having an increased number of visible colleagues within one's 120° field of vision does not lead to a decrease in the number of work-process interactions in open-plan offices. H4 is rejected due to its lack of statistical significance, compounded by the scarcity of research on this topic. Previous studies focusing on employees' field of vision primarily examined its impact on employees' preferences within open-plan office layouts. For instance, Sailer et al. (2021) suggested that employees with a narrower field of vision (lower outdegree) tended to rate their workspaces more favorably in terms of productivity. Conversely, Alavi et al. (2018) discovered that employees who desired social interaction in open-plan offices preferred workstations with higher outdegree.

Hypothesis 5 (H5) suggested a negative correlation between binocular density and the number of work-process interactions. Regression analyses conducted for Öncüoğlu Architects and Tepe Home offices supported this hypothesis. Specifically,

the results indicated that higher binocular density was associated with fewer work-process interactions (β=-0.93, SE=12.15, $p<0.014$ for Öncüoğlu Architects; β=-0.53, SE=14.30, $p<0.05$ for Tepe Home).

In essence, these analyses revealed that a higher ratio of visible employees to the area of the 120° isovist (indicative of higher binocular density) was associated with fewer work-process interactions within the open-plan office setting. These findings align with previous research by Bernstein and Turban (2018), who also discovered that increased visibility decreased face-to-face interactions in open-plan offices. Hence, it can be inferred that employees in open-plan offices tend to prefer alternative communication methods over traditional face-to-face interactions. Thus, Hypothesis 5 (H5), proposing a negative correlation between binocular density and work-process interactions, is accepted.

Hypothesis 6 (H6) suggested a negative correlation between the targeted visibility ratio and the number of work-process interactions. This ratio was measured at two different employee distances: personal distance (60 cm) and social distance (150 cm).

Sub-hypothesis H6a suggested a negative correlation between the targeted visibility ratio at 60 cm (personal distance) and the number of work-process interactions. However, the regression analysis revealed no significant relationship between the targeted visibility ratio at 60 cm and the number of work-process interactions in open-plan offices. The study's findings indicate that observing more employees walking and sitting at a personal distance (60 cm) while facing forward at the desk does not impact the number of work-

process interactions. Consequently, H6a is rejected due to its lack of significance.

Similarly, sub-hypothesis H6b suggested a negative correlation between the targeted visibility ratio at 150 cm (social distance) and the number of work-process interactions. Yet, the regression analysis revealed no significant relationship between the targeted visibility ratio at 150 cm and the number of work-process interactions in open-plan offices. In other words, the study's findings indicate that observing more employees walking and sitting at a social distance (150 cm) while facing forward at the desk does not impact the number of work-process interactions. Therefore, H6b is also rejected because of insignificance.

In open-plan offices, the number of visible employees significantly impacts work-process interactions. When density (the number of people per unit in 360° isovist) and binocular density (the number of people per unit in 120° isovist) increase, work-process interactions tend to decrease. This negative correlation suggests that the number of work-process interactions diminishes as more colleagues are visible. Therefore, optimizing visibility and balancing how many people are in the field of vision can be crucial for fostering effective interaction in open-plan offices.

The next chapter explains theoretical and practical implications of the study and limitations of the study and suggestions for future studies.

CHAPTER 6

CONCLUSION

6.1. Implications of the Study

Theoretical Implications

Open-plan offices introduced integrated workspaces into the office design, enabling employees to interact more. However, these integrated and more visible spaces invade employees' visual privacy and become one of the main problems of open-plan offices. Therefore, examining deeply how low visual privacy affects work-process interactions becomes essential to increase interaction possibilities in open-plan offices by preserving employees' visual privacy. As employees' visual privacy is negatively correlated with increased visibility, this study evaluates how visual privacy influences work-process interactions in open-plan offices using analyses of generic and targeted visibility.

The study used qualitative and quantitative research approaches to compare interaction patterns obtained through observation with visibility analysis outputs obtained through DepthMap software. The first phase of the study (qualitative

research approach) aimed to detect work-process interaction patterns through a survey. The study's second phase (quantitative research approach) was conducted through generic and targeted visibility analysis. In contrast to previous studies, the study's second phase consisted of computer-based methods to investigate visual privacy in open-plan offices. DepthMap software was used to measure degree, density, and visual integration through generic visibility analysis and outdegree and binocular density through targeted visibility. Then, a new script for DepthMap was written to measure the targeted visibility ratio. The outputs of these analyses and the survey were compared to understand how visual privacy levels of employees affected employees' work-process interactions in open-plan offices.

Conducting the study in two different architectural design firms enabled to understand whether various plan layouts have different visibility and visual privacy opportunities. The findings of the thesis suggest that visibility values in office settings are affected by plan shapes. Offices with a rectangle plan layout are more integrated than offices with a fragmented layout like wing shapes. Thus, different spatial layouts result in differences in visibility levels. Each desk has similar targeted and generic visibility values in offices with a rectangular plan layout. On the other hand, targeted and generic visibility values are diverse in offices with more fragmented layouts. Thus, in order to provide equal visibility values for each employee in open-plan offices, more compact plan layouts with low fragmentation could be preferred rather than wing shapes like L-shape.

In all generic and targeted visibility parameters, density values for 120° and 360° isovists are determinant factors for the number of work-process interactions. It means

that the ratio of visible employees to the area of the visual field of 120° and 360° affects the number of work-process interactions in open-plan offices. The study results show a negative correlation between generic visibility (density) values and the number of work-process interactions. Moreover, a negative correlation was found between targeted visibility (binocular density) and the number of work-process interactions. Therefore, more visible employees per unit in 120° and 360° isovists result in fewer work-process interactions in open-plan offices. As increased generic and targeted visibility means decreased visual privacy, a positive correlation exists between visual privacy and work-process interactions. In other words, when an employee has a desk with low visual privacy or high visibility, this employee avoids interacting with their colleagues in open-plan offices. The findings of this study support Bernstein and Turban (2018) that employees decrease face-to-face interactions with their colleagues when they become more visible or transparent. They also claimed that because of the transparency of open offices, employees avoid face-to-face interaction and choose to interact with e-mail. Therefore, the effects of visual privacy on work-process interactions in open-plan offices are not as same as previously thought. In conclusion, the findings of this study suggest that more visibility does not result in more work-process interaction in open-plan offices unless employees' visual privacy is preserved (Figure 69).

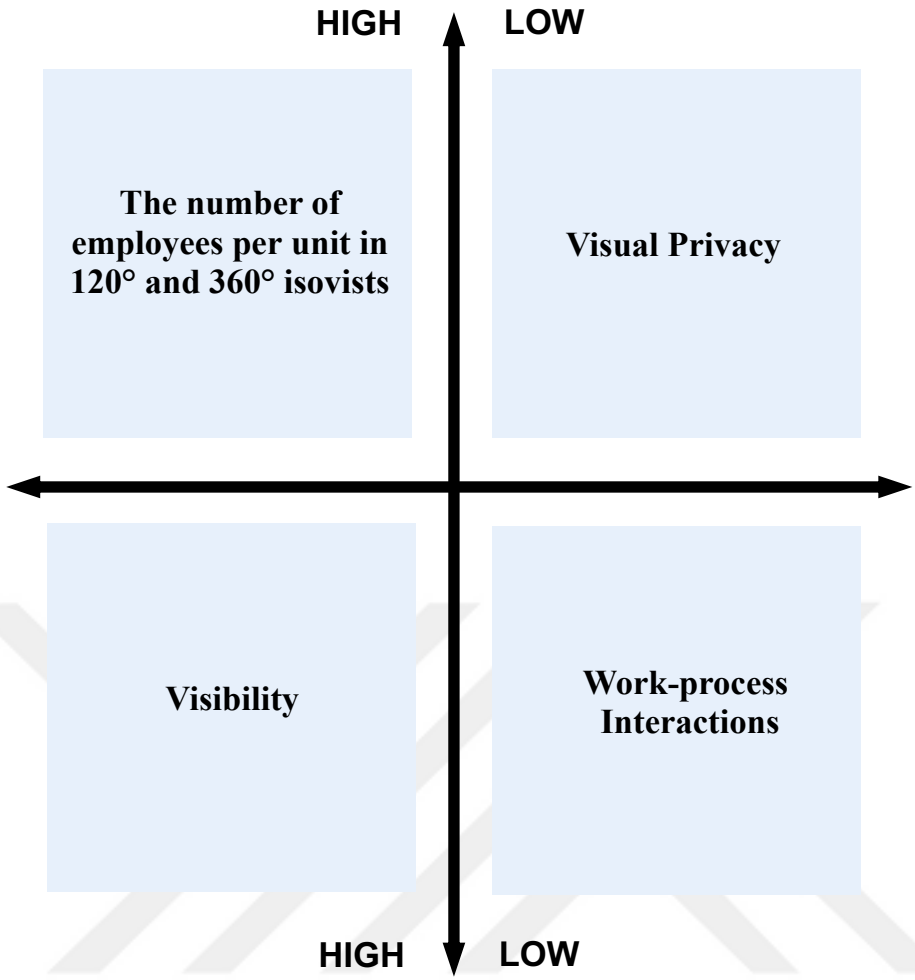


Figure 69. Summary of outcomes of the thesis

Practical Implications

Based on this study, following open-plan office design guidelines were suggested:

1. Interior architects should create compact floor plans such as rectangles or squares rather than fragmented L-shaped layouts to provide equal visibility levels for each employee.
2. Interior architects should locate and arrange employees' desks so they are not directly visible while facing forward to increase interaction by preserving

employees' visual privacy. They should try to decrease desk transparency and minimize employees' visual field by locating desks behind the structural elements in the building, like columns. If this is not possible, they should design visual barriers like furniture or partial partitions.

3. Interior architects should change the rotation of desks to find the most suitable field of vision with a minimum number of visible colleagues. If applicable, they should use spatial network analysis tools like DepthMap to measure the visual field of each employee while designing furniture layouts. They need to use 120° and 360° isovists for calculations.
4. Interior architects should enable employees to have control over their desks. Instead of fixed ones, interior architects need to design movable visual barriers for each desk that employees themselves can control. Thus, employees can arrange their visual privacy and interaction possibilities according to the needs of working tasks.

6.2. Limitations of the Study and Suggestions for Future Studies

This study also has some limitations. The study was conducted with a small number of participants because of the coronavirus pandemic. During these days, most employees preferred to work from home, so it was hard to reach many employees. Future studies could enhance the validity of this study's results by investigating the impact of visual privacy on work-process interactions within the open-plan office environment of a large-scale company. Moreover, the data is collected through a

survey to detect work-process interactions. However, not using technological devices that track user behaviors to record interaction among employees more precisely can be another potential limitation of the study. Another study limitation was that two office settings were from the same business line. Diverse lines of work require different privacy and visibility preferences while working. Hence, it would be beneficial to study offices beyond architectural design firms to explore whether different occupations have varying requirements concerning interaction, visual privacy, and visibility. Moreover, while this study delved deeply into visual privacy in open-plan offices, it's essential to recognize that acoustical privacy is also crucial. Noise and sound levels can significantly impact employee behavior and interactions. To better understand these dynamics, future research should explore both acoustical and visual privacy and how they influence employee interactions in open-plan offices.

This study contributes to the literature regarding its methodology and findings that reveal a different perspective on visual privacy and interaction in open-plan offices. The study results can be helpful for interior architects, office design experts, spatial analysts, and organizational psychologists. Interior architects can design employee-friendly open-plan offices that increase interaction while preserving visual privacy with the guidance of this study. Moreover, new spatial analysis methods for architecture can be developed based on the novel methodology of this study.

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APPENDICES

Appendix A. Observation Sheets

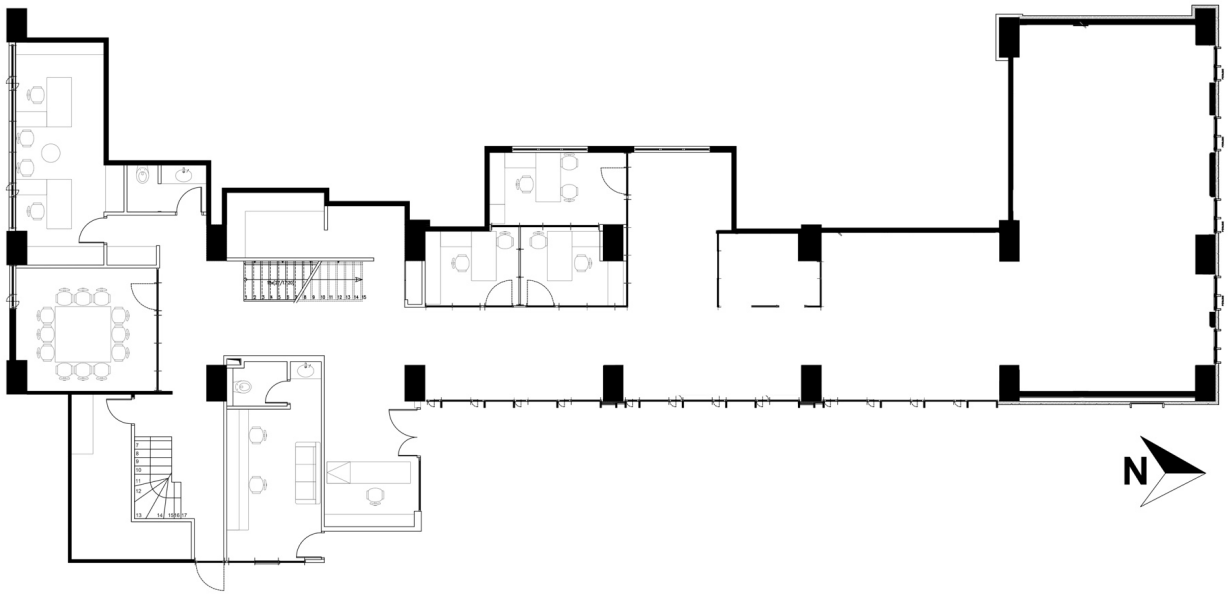
Observation Grid: Work-process Interactions In Open-Plan Offices

Company Name: Date: Start Time: Finish Time:

Number of the First Workspace (1-32)	Number of the Second Workspace (1-32)	Interaction Types		Duration of the Interaction (in minutes)	Comments
		Work-process Interactions	Social Interactions		

PHASE I – Layout of the Open-plan Office

Company Name: Date:



Appendix B. Survey (English)

Age:	**Participant No:**
Gender:	
Occupation:	

The Effects of Visual and Acoustical Privacy on Work-process Interactions in Open-Plan Offices

PART I (Open-ended Questions)

1. How would you evaluate your personal workspace in terms of visual privacy?

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2. How would you evaluate your personal workspace in terms of acoustical privacy?

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3. How would you evaluate your personal workspace in terms of background noise? Do you get distracted from overhearing other employees' conversations in your workspace?

4. How often are you distracted from your work in your workplace, during a normal workday?

5. How do you feel when the number of employees increases around your workplace?

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6. How do you feel when you lose the sense of control over your workplace?

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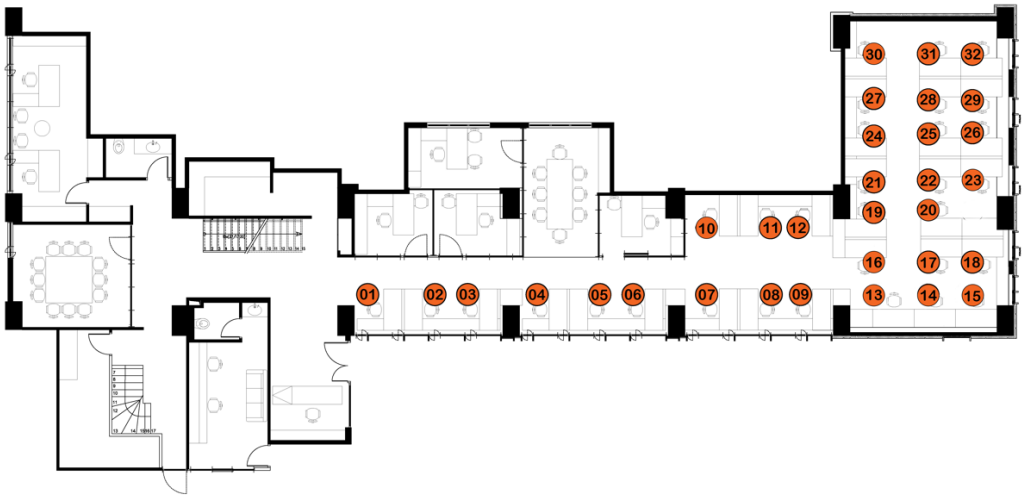
PART II (Open-ended Questions)

7. Please indicate the number of your workspace on the plan.

Answer: .....

8. Please indicate the workspace number of your colleague with whom you interact the most for work processes last year.



Answer: .....

PART III

Please answer the following questions according to the work-process interaction that you indicated in Part II.

9. What was the duration of this interaction? (duration in minutes)

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10. Was this interaction with more than three people?

◯ Yes

◯ No

11. Did you plan this interaction before it takes place?

◯ Yes

◯ No

12. What is the type of this interaction?

◯ Social Interaction

◯ Work-process Interaction

◯ Both

13. What is the main reason to interact with the indicated colleague the most for work processes?

◯ Expert Advice

◯ Improvement

◯ Decision Making

◯ Innovation

14. Are you and your colleague with whom you interact from the same team?

◯ Yes

◯ No

PART IV (Open-ended Questions)

15. How the coronavirus pandemic has affected your working conditions?

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16. How the coronavirus pandemic has affected your perceptions of your workspace?

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17. How the coronavirus pandemic has affected your interactions with your colleagues in the open-plan office?

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Appendix C. Survey (Turkish)

Yaş:	**Katılımcı No:**
Cinsiyet:	
Meslek:	

Açık Ofislerde Görsel ve İşitsel Mahremiyetin Çalışanların Etkileşimleri Üzerindeki Etkileri

BÖLÜM I (Açık Uçlu Sorular)

1. Kişisel çalışma alanınızı görsel mahremiyet açısından nasıl değerlendirirsiniz?

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2. Kişisel çalışma alanınızı işitsel mahremiyet açısından nasıl değerlendirirsiniz?

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3. Kişisel çalışma alanınızı arka plan gürültüsü açısından nasıl değerlendirirsiniz? Ofisteki diğer çalışanların konuşmalarına kulak misafiri olmaktan rahatsız oluyor musunuz?

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4. Normal bir iş gününde, ofiste çalışırken ne sıklıkla dikkatiniz dağılıyor?

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5. Çalışma alanınızın etrafında, iş arkadaşlarınızın sayısı arttığında ne hissediyorsunuz?

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6. Ofisteki çalışma alanınız üzerindeki hakimiyetinizi kaybettiğinizde ne hissedersiniz?

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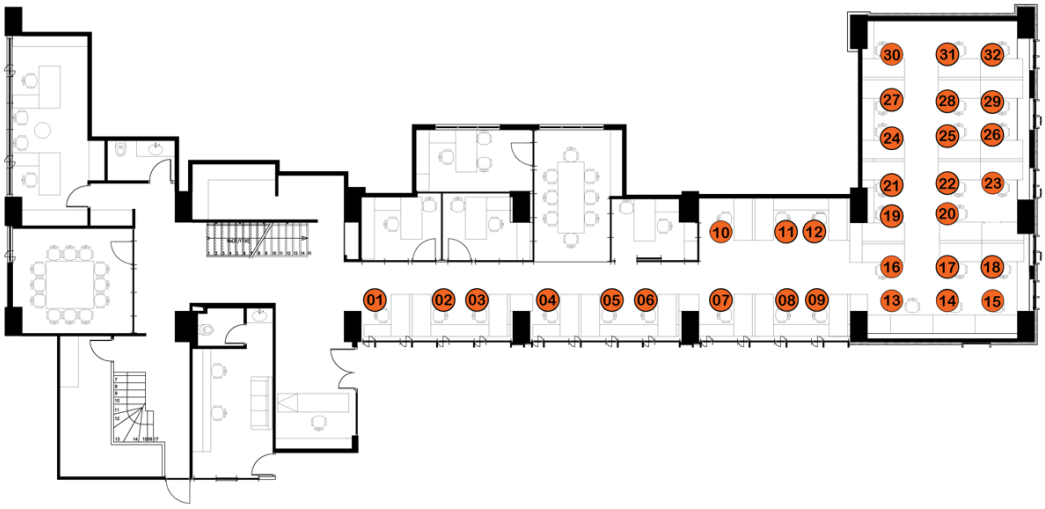
BÖLÜM II (Açık Uçlu Sorular)

7. Lütfen aşağıdaki kat planına göre çalışma masanızın numarasını belirtin.



Cevap: .....

8. Lütfen aşağıdaki kat planına göre, geçen yıl iş ile ilgili en çok etkileşim kurduğunuz iş arkadaşınızın masa numarasını belirtin.

Cevap: .....

BÖLÜM III

Lütfen aşağıdaki soruları Bölüm II' de belirttiğiniz iş ile ilgili etkileşime göre cevaplayınız.

9. Bu etkileşimin süresi ortalama kaç dakika idi?

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.....

10. Bu etkileşim üçten fazla kişi ile mi oldu?

◯ Evet

◯ Hayır

11. Bu etkileşimi gerçekleştirmeden önce planlamış mıydınız?

◯ Evet

◯ Hayır

12. Bu etkileşimin türü nedir?

◯ Sosyal Etkileşim

◯ İş ile İlgili Etkileşim

◯ Hepsi

13. Belirttiğiniz iş ile ilgili etkileşimin temel nedeni nedir?

◯ Uzman tavsiyesi almak

◯ İlerleme kaydetmek

◯ Karar vermek

◯ Yenilik yapmak

14. Etkileşimde bulunduğunuz iş arkadaşınızla aynı ekipten misiniz?

◯ Evet

◯ Hayır

BÖLÜM IV (Açık Uçlu Sorular)

15. Covid-19 salgını çalışma koşullarınızı nasıl etkiledi?

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16. Covid-19 salgını çalışma alanınıza ilişkin algınızı nasıl etkiledi?

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17. Covid-19 salgını açık ofisteki iş arkadaşlarınızla olan etkileşimlerinizi nasıl etkiledi?

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Appendix D. Bilkent University Ethics Committee Approval

Bilkent Üniversitesi
Akademik İşler Rektör Yardımcılığı

Tarih : 23 Kasım 2021

Gönderilen : Halime Demirkan, Gizem Yenel Güler

Gönderen : H. Altay Güvenir
İnsan Araştırmaları Etik Kurulu Başkanı

Konu : *"The Effects of ..."* çalışması etik kurul onayı

Üniversitemiz İnsan Araştırmaları Etik Kurulu, 23 Kasım 2021 tarihli görüşme sonucu, *"The effects of visual and acoustical privacy on work-process interactions in open-plan offices"* isimli çalışmanız kapsamında yapmayı önerdiğiniz etkinlik için etik onay vermiş bulunmaktadır. Onay, ekte verilmiş olan çalışma önerisi, çalışma yürütücüleri ve bilgilendirme formu için geçerlidir.

Bu onay, yapmayı önerdiğiniz çalışmanın genel bilim etiği açısından bir değerlendirmedir. Çalışmanızda, kurulumuzun değerlendirmesi dışında kalabilen özel etik ve yasal sınırlamalara uymakla ayrıca yükümlüsünüz.

Kovid-19 salgını nedeniyle konulmuş olan kısıtlamaların yürürlükte olduğu süre içinde, tüm komite toplantıları elektronik ortamda yapılmaktadır; aşağıda isimleri bulunan Bilkent Üniversitesi Etik Kurulu Üyeleri adına bu yazıyı imzalama yetkisi kurul başkanındadır.

Etik Kurul Üyeleri:

Ünvan / İsim	**Bölüm / Uzmanlık**	
Prof.Dr. H. Altay Güvenir	Bilgisayar Mühendisliği	Başkan
Prof.Dr. Erdal Onar	Hukuk	Üye
Prof.Dr. Haldun Özaktaş	Elektrik ve Elektronik Müh.	Üye
Doç.Dr. Işık Yuluğ	Moleküler Biyoloji ve Genetik	Üye
Dr. Öğr. Üyesi Burcu Ayşen Ürgen	Psikoloji	Üye
Doç.Dr. Çiğdem Gündüz Demir	Bilgisayar Mühendisliği	Yedek Üye
Dr. Öğr. Üyesi A.Barış Özbilen	Hukuk	Yedek Üye

Kurul karar/toplantı No: 2021_11_23_01

Bilkent Üniversitesi, 06800 Bilkent, Ankara • Telefon: (312) 290 12 13 • (312) 290 12 14 • Faks: (312) 266 41 52

(Form Student_EN')

Ethics form for graduate and undergraduate students - human participants

Note - group projects fill in one copy with all your names on it. Consult your project supervisor for advice before filling in the form.

Your name(s): Gizem Yenel Güler **Project Supervisor: Halime Demirkan**

A. Write your name(s) and that of your supervisor above.
B. Read section 2 that your supervisor will have to sign. Make sure that you cover all these issues in section 1. Discuss what you are going to put on the form with your project supervisor.
C. Sign the form and get your project supervisor to complete section 2 and sign the form.

1. Project Outline (to be completed by student(s))

(i) Full Title of Project:

The effects of visual and acoustical privacy on work-process interactions in open-plan offices

(ii) Aims of project:

The main aim of this study is to investigate the possible effects of visual and acoustical privacy on work-process interactions in open-plan offices through generic visibility analysis, targeted visibility analysis and acoustical analysis. Therefore, the study aims to find out which analyses (generic visibility, targeted visibility and acoustical analysis) are positively correlated with work-process interaction patterns in open-plan offices. It aims to rank these analyses according to their impact on work-process interactions. The study also aims to demonstrate the applicability of visibility analysis to open-plan offices and provide design guidelines for open-plan offices in terms of employee work-process interactions, visual privacy and acoustical privacy.

(iii) What will the participants have to do? (brief outline of procedure; please draw attention to any manipulation that could possibly be judged as deception; ***for survey work, a copy of the survey should be attached to this form*****):**

The data collection will start with the observation of the selected open-plan office in order to have a preliminary understanding of work-process interactions in the open-plan office. The observation procedure has two phases. The first phase of the observation will be conducted while employees are not in the office. Location of workplaces and replacements of visual barriers will be recorded. The second phase of the observation is conducted while employees are working in the open-plan office during working hours. The observer will remain hidden from the subjects of the study in order to prevent cognitive biases. The observer will record interaction (location/type/duration). Following the observation process, a survey with both open-ended and close-ended questions will be distributed to employees working in the selected open-plan office in order to discover perceptions and work-process interactions of employees in the open-plan office. Participants are expected to fill out the questionnaire.

(iv) What sort of people will the participants be and how will they be recruited? In the case of children state age range. (*Any participant who has not lived through his/her 18th birthday is considered to be a child!*)

Participants will be architects, interior architects, landscape architects and construction engineers who work at the selected architecture firm. Participants will be selected from employees whose workstations are located in the open-plan part of the selected office. All participants will be over 18 years old.

*If you are testing children or other vulnerable individuals, state whether all applicants have CRB** clearance*

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* Adapted from *www.york.ac.uk/depts/psych/www/research/ethics/HumanProjForm.doc*

** Criminal Records Bureau – Please attach relevant clearance documentation.

[redacted]

(v) **What sort stimuli or materials will your participants be exposed to? Tick the appropriate boxes and then explain the form that they take in the space below, please draw attention to any content that could conceivably upset your participants).**
Questionnaires[X]; Pictures[ ]; Sounds [ ]; Words[ ]; Caffeine[ ]; Alcohol[ ]; Other[ ].

Observation Sheet
Survey Questionnaire Form

See enclosed documents.

(vi) **Consent** Informed consent must be obtained for all participants before they take part in your project. The form should clearly state what they will be doing, drawing attention to anything they could conceivably object to subsequently. It should be in language that the person signing it will understand. It should also state that they can withdraw from the study at any time and the measures you are taking to ensure the confidentiality of data. If children are recruited from schools you will require the permission of the head teacher, and of parents. Children over 14 years should also sign an individual consent form themselves. When testing children you will also need Criminal Records Bureau clearance. Testing to be carried out in any institution (prison, hospital, etc.) will require permission from the appropriate authority. (Please include documentation for such permission.)
Who will you seek permission from?

Permission will be obtained from participants themselves.

Please attach the consent form you will use. Write the "brief description of study" in the words that you will use to inform the participants here.

This study aims to investigate the possible effects of visual and acoustical privacy on work-process interactions in open-plan offices. The survey consists of four sections with open-ended and close-ended questions. The first section of the survey concentrates on employee perceptions of workspaces regarding visual and acoustical privacy, crowding, territoriality and noise. The second section of the survey is formed to detect work-process interaction patterns in the open-plan office. Each workstation on the office floor plan is assigned a number in order to gather the work-process interaction diagram systematically. The first question of the second section of the survey asks participants to indicate the number of their workspaces, while the second question asks participants to indicate the workspace numbers of their colleagues with whom they interact the most for work processes. The third part of the survey consists of close-ended questions in order to determine work-process interaction characteristics in the open-plan office. The last section of the survey is designed to detect the impacts of the Covid-19 pandemic on working conditions, perceptions of workspaces and interactions with their colleagues in the open-plan office. The participants will voluntarily participate in the study. All participants are over 18 years old. Any information obtained in this study will only be reported and published for scientific purposes. Any personal information about the participants will be kept confidential. The names of the participants will be coded.

(vii) **Debriefing - how and when will participants be informed about the experiment, and what information you intend to provide? If there is any chance that a participant will be 'upset' by taking part in the experiment what measures will you take to mitigate this?**

All participants will be informed prior to the questionnaire. Aims of the study and the content of the questionnaire will be explained to participants. They will be asked to sign the informed consent form. If a participant will be upset by taking part in the study, s/he can withdraw from the study by informing the researcher at any time.

(viii) **What procedures will you follow in order to guarantee the confidentiality of participants' data?** Personal data (name, addresses etc.) should only be stored if absolutely necessary and then only in such a way that they cannot be associated with the participant's experimental data.

Any information obtained in this study will only be reported and published for scientific purposes. Any personal information about the participants will be kept confidential. The names of the participants will be coded.

(vii) Give brief details of other special issues the ethics committee should be aware of.

The participants will not be compensated for their participation in this research.

(viii) Tick any of the following that apply to your project

[ ] it uses Bilkent facilities;
[ ] it uses stimuli designed to be emotive or aversive;
[ ] it requires participants to ingest substances (e.g., alcohol);
[ ] it require participants to give information of a personal nature;
[ ] it involves children or other vulnerable individuals;
[ ] it could put you or s[redacted]njury

Student's signature: ...[redacted]..... date: ...09.11.2021.....
(all students must sign[redacted]ct, please initial all other pages)

The signatures here signify that researchers will conform to the accepted ethical principles endorsed by relevant professional bodies, in particular to

Declaration of Helsinki (WMA):
http://www.wma.net/en/30publications/10policies/b3/index.html

Ethical Principles of Psychologists and Code of Conduct (APA):
http://www.apa.org/ethics/code2002.html

Ethical Standards for Research with Children (SCRD):
http://www.srcd.org/about-us/ethical-standards-research

2. Supervisor's assessment (supervisor to complete - circle yes or no)

(Yes)/No - *I confirm that I have secured the resources required by this project, including any workshop time, equipment, or space that are additional to those already allocated to me.*
(Yes)/No - *The design of this study ensures that the dignity, welfare and safety of the participants will be ensured and that if children or other vulnerable individuals are involved they will be afforded the necessary protection.*
(Yes)/No - *All statutory, legislative and other formal requirements of the research have been addressed (e.g., permissions, police checks)*
(Yes)/No - *I am confident that the participants will be provided with all necessary information before the study, in the consent form, and after the study in debriefing.*
(Yes)/No - *I am confident the participant's confidentiality will be preserved.*
(Yes)/No - *I confirm that students involved have sufficient professional competency for this project.*
(Yes)/No - *I consider that the risks involved to the student, the participants and any third party are insignificant and carry no special supervisory considerations. If you circle "no" please attach an explanatory note.*
(No)/Yes - *I would like the ethics committee to give this proposal particular attention. (Please state why below)*

Supervisor's signature: [redacted]..... date: .....09.11.2021.....

Please e-mail an electronic version of this word processed form (without signatures) along with other application material to the committee to start the evaluation process. Paper copies of all application material, (properly signed where indicated, and initialed on all other pages) should be sent after possible modifications suggested by the committee are finalized.

Bilkent University does not allow the use of students of research investigators as participants. Students who have the potential of being graded by the investigators during or following the semester(s) in which the study is being carried out should not participate in the study. Students may not receive any credit for any university course, with the exception of the GE250/GE251 courses, for their participation. The GE250 and GE251 (Collegiate Activities I and II) courses include an optional activity which encompasses volunteering as a participant in a research project.

[redacted]

Enclosed:
1) Observation Sheet
2) Survey Questionnaire Form

BİLGİLENDİRİLMİŞ ONAM FORMU

Açık Ofislerde Görsel ve İşitsel Mahremiyetin Çalışanların Etkileşimleri Üzerindeki Etkileri

Bilgilendirme Formu:

Bu çalışma Bilkent Üniversitesi İç Mimarlık ve Çevre Tasarımı bölümü doktora öğrencisi Gizem Yenel Güler'in doktora tezi kapsamında yürütülmektedir. Çalışmanın amacı, açık plan ofislerdeki görsel ve işitsel mahremiyetin çalışanların birbirleriyle olan etkileşimleri üzerindeki etkisini gözlemlemektir. Anket 4 bölümden oluşmaktadır. Anketin ilk bölümünde katılımcıların kendi çalışma ortamlarını mahremiyet, kişisel alan ve kalabalık gibi unsurlara göre değerlendirecekleri açık uçlu sorular bulunmaktadır. Anketin ikinci bölümünde ise ofisteki çalışma masalarının numaralandırılıp yerleşiminin gösterildiği kat planı yer almaktadır. Çalışanlardan kendi masalarını ve son bir yılda iş ile ilgili en çok etkileşim kurdukları meslektaşının masa numarasını belirtmesi istenecektir. Anketin üçüncü bölümünde bir önceki bölümde belirtilen iş etkileşimi ile ilgili çoktan seçmeli sorular bulunmaktadır. Anketin son bölümünde ise Covid-19 salgınının, çalışanların çalışma ortamlarına ilişkin algılarına etkileri ile ilgili açık uçlu sorular bulunmaktadır. Çalışma sonunda açık ofislerdeki mahremiyetin çalışanların birbirleriyle olan etkileşimleri üzerindeki etkileri elde edilecek ve çalışan dostu açık ofislerin tasarlanmasına katkı sağlanacaktır.

Bu çalışmaya katılım gönüllülük esasına dayanmaktadır. Anket boyunca paylaştığınız kişisel veriler saklı kalacak ve paylaşılmayacaktır. Anketten elden edilen veriler akademik amaçla yayınlanabilir ancak katılımcıların kişisel bilgileri gizli tutulacaktır. Çalışmanın herhangi bir riski yoktur. Çalışmanın herhangi bir aşamasında çalışmaya katılımınızı sonlandırabilirsiniz.

Çalışmaya katılmak için 18 yaşından büyük olmanız gerekmektedir.

[redacted]

Onam Formu:

Yukarıda yazılan bilgilendirme yazısını okudum ve anladım. Bilgilendirmeyi okumak ve düşünmek için yeterli zamanım oldu. Bu çalışmaya gönüllü olarak katılıyorum ve çalışma kapsamında elde edilen verilerin, anonim olmak koşulu ile kullanılmasına ve yayınlanmasına izin veriyorum.

Ad-Soyad:

E-mail:

Tarih:

İmza:

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Bilkent Üniversitesi
E-mail: demirkan@bilkent.edu.tr

Araştırmacının İmzası:

[redacted]

[redacted]

Appendix E. Written Codes in Python

```
import sys
import subprocess
import numpy as np
import geopandas
import matplotlib.pyplot as plt
import os
from csv import reader
from tkinter import *



root = Tk()
root.title("Targeted Visibilty Analysis by Gizem Yenel")
root.geometry("800x500")
root.iconbitmap("in.ico")
iM = PhotoImage(file="axial6.png")
my_canvas = Canvas(root, width=2000, height=2000)
my_canvas.pack(fill="both", expand=True)
my_canvas.create_image(0,0, image=iM, anchor="nw")


def button1():
    filePNG1=graphName.get()
    global filePNG
    filePNG =filePNG1

def button2():
    filePNS1=shpName.get()
    global filePNS
    filePNS =filePNS1

def button3():
    clientPx1=clientDeskX.get()
    global clientPx
    clientPx=clientPx1

def button4():
    clientPy1=clientDeskY.get()
    global clientPy
    clientPy=clientPy1
```

```
def button5():
    pointX1=agentStartX.get()
    global pointX
    pointX = float(pointX1)


def button6():
    pointY1=agentStartY.get()
    global pointY
    pointY=float(pointY1)

def button7():
    rangeX1=agentLimitX.get()
    global rangeX
    rangeX=rangeX1

def button8():
    rangeY1=agentLimitY.get()
    global rangeY
    rangeY=rangeY1


def button9():
    intervalA1 = agentInterval.get()
    global intervalA
    intervalA = int(intervalA1)

def button10():
    visibilityArea1 = visibleArea.get()
    global visibilityArea2
    visibilityArea2 = float(visibilityArea1)


def button11():
    gridSize1 = gridSize2.get()
    global gridSize
    gridSize = float(gridSize1)
```

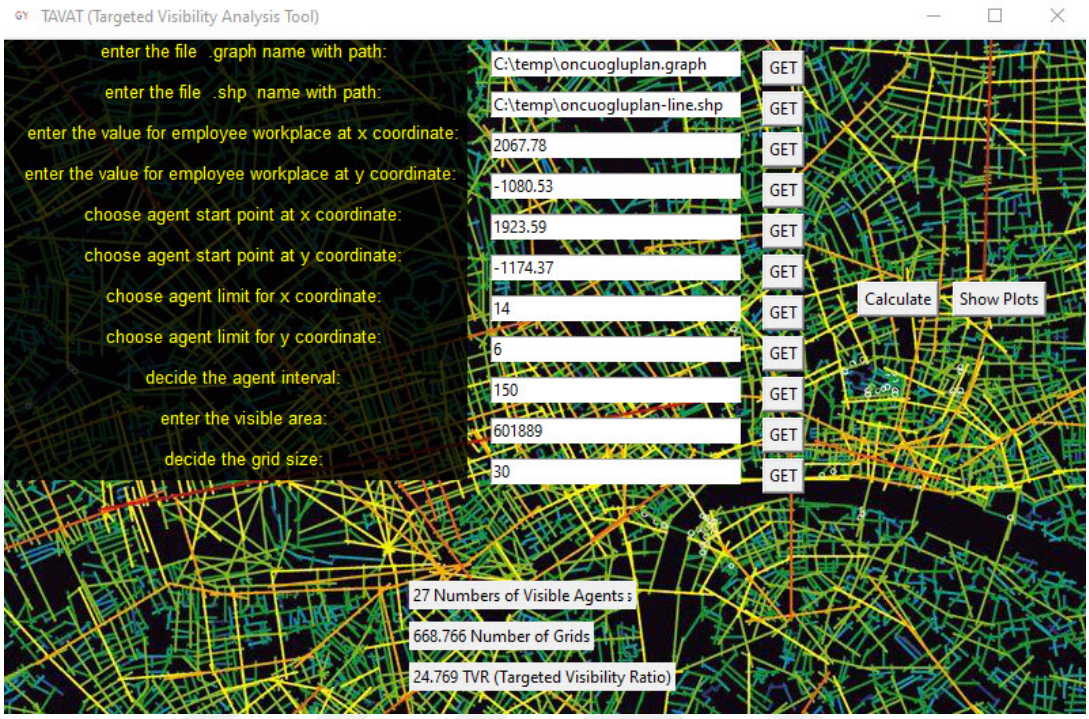
```
graphName = Entry(root, width=30, )
graphName.pack()
graphName.place(x=360, y=10)

myButton1 = Button(root, text="GET", command=button1)
#myButton1.pack()

shpName = Entry(root, width=30, )
shpName.pack()
shpName.place(x=360, y=40)

myButton2 = Button(root, text="GET", command=button2)
#myButton2.pack()

clientDeskX = Entry(root, width=30, )
clientDeskX.pack()
clientDeskX.place(x=360, y=70)

myButton3 = Button(root, text="GET", command=button3)
#myButton3.pack()

clientDeskY = Entry(root, width=30, )
clientDeskY.pack()
clientDeskY.place(x=360, y=100)

myButton4 = Button(root, text="GET", command=button4)
#myButton4.pack()

agentStartX = Entry(root, width=30, )
agentStartX.pack()
agentStartX.place(x=360, y=130)

myButton5 = Button(root, text="GET", command=button5)
#myButton5.pack()

agentStartY = Entry(root, width=30, )
agentStartY.pack()
agentStartY.place(x=360, y=160)
```

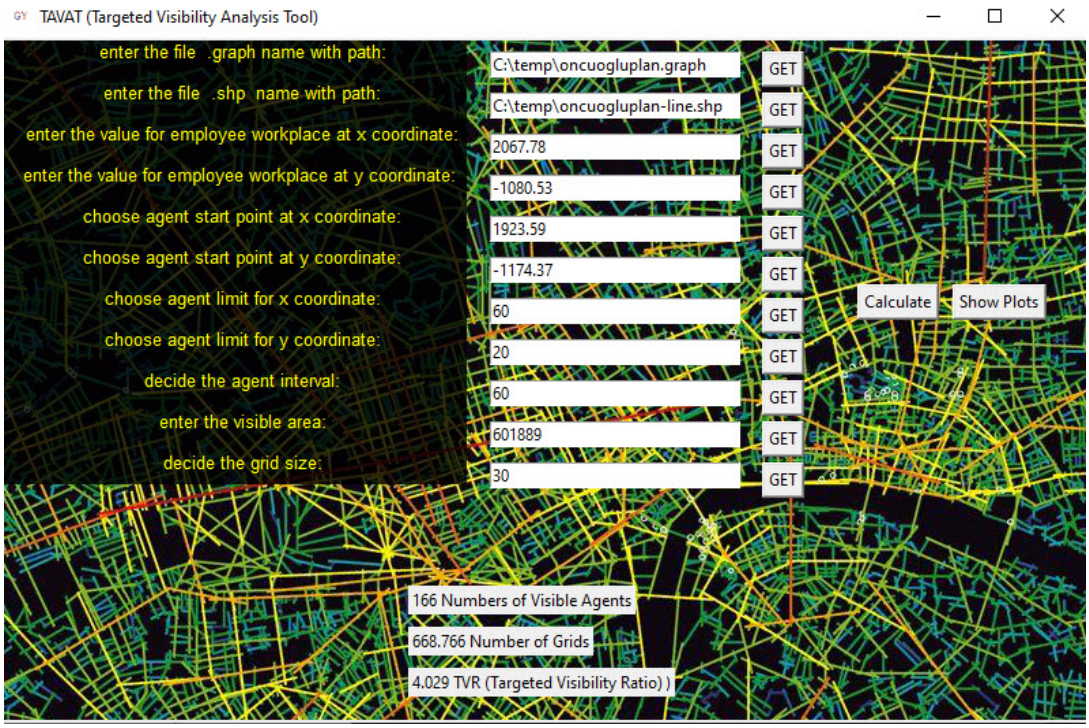
```
agentStartY = Entry(root, width=30, )
agentStartY.pack()
agentStartY.place(x=360, y=160)

myButton6 = Button(root, text="GET", command=button6)
#myButton6.pack()

agentLimitX = Entry(root, width=30, )
agentLimitX.pack()
agentLimitX.place(x=360, y=190)

myButton7 = Button(root, text="GET", command=button7)
#myButton7.pack()

agentLimitY = Entry(root, width=30, )
agentLimitY.pack()
agentLimitY.place(x=360, y=220)

myButton8 = Button(root, text="GET", command=button8)
#myButton8.pack()

agentInterval = Entry(root, width=30, )
agentInterval.pack()
agentInterval.place(x=360, y=250)

myButton9 = Button(root, text="GET", command=button9)
#myButton9.pack()

visibleArea = Entry(root, width=30, )
visibleArea.pack()
visibleArea.place(x=360, y=280)

myButton10 = Button(root, text="GET", command=button10)
#myButton10.pack()

gridSize2 = Entry(root, width=30, )
gridSize2.pack()
gridSize2.place(x=360, y=310)
```

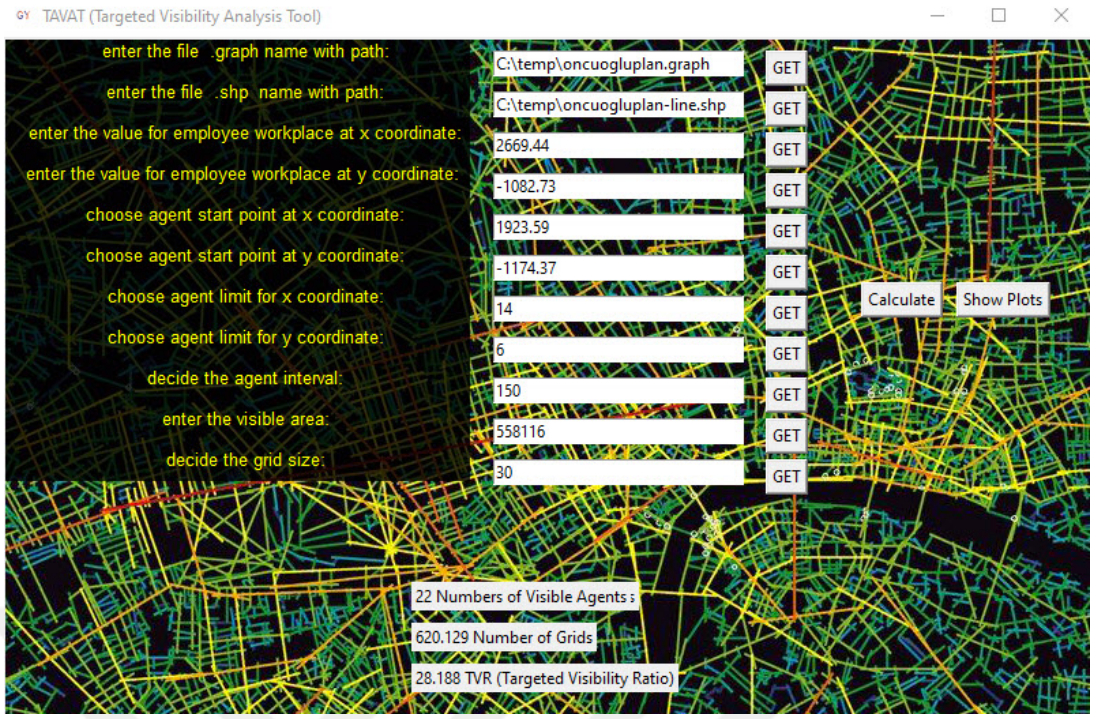
```
myButton11 = Button(root, text="GET", command=button11)
#myButton11.pack()

button1_window = my_canvas.create_window(560, 10, anchor="nw", window=myButton1)
button2_window = my_canvas.create_window(560, 40, anchor="nw", window=myButton2)
button3_window = my_canvas.create_window(560, 70, anchor="nw", window=myButton3)
button4_window = my_canvas.create_window(560, 100, anchor="nw", window=myButton4)
button5_window = my_canvas.create_window(560, 130, anchor="nw", window=myButton5)
button6_window = my_canvas.create_window(560, 160, anchor="nw", window=myButton6)
button7_window = my_canvas.create_window(560, 190, anchor="nw", window=myButton7)
button8_window = my_canvas.create_window(560, 220, anchor="nw", window=myButton8)
button9_window = my_canvas.create_window(560, 250, anchor="nw", window=myButton9)
button10_window = my_canvas.create_window(560, 280, anchor="nw", window=myButton10)
button11_window = my_canvas.create_window(560, 310, anchor="nw", window=myButton11)

my_canvas.create_text(180,10, text="enter the file  .graph name with path: ", font=("Helvetica", 10), fill="yellow")
my_canvas.create_text(180,40, text="enter the file  .shp  name with path: ", font=("Helvetica", 10), fill="yellow")
my_canvas.create_text(180,70, text="enter the value for employee workplace at x coordinate: ", font=("Helvetica", 10), fill="yellow")
my_canvas.create_text(180,100, text="enter the value for employee workplace at y coordinate:  ", font=("Helvetica", 10), fill="yellow")
my_canvas.create_text(180,130, text="choose agent start point at x coordinate: ", font=("Helvetica", 10), fill="yellow")
my_canvas.create_text(180,160, text="choose agent start point at y coordinate: ", font=("Helvetica", 10), fill="yellow")
my_canvas.create_text(180,190, text="choose agent limit for x coordinate: ", font=("Helvetica", 10), fill="yellow")
my_canvas.create_text(180,220, text="choose agent limit for y coordinate: ", font=("Helvetica", 10), fill="yellow")
my_canvas.create_text(180,250, text="decide the agent interval: ", font=("Helvetica", 10), fill="yellow")
my_canvas.create_text(180,280, text="enter the visible area: ", font=("Helvetica", 10), fill="yellow")
my_canvas.create_text(180,310, text="decide the grid size: ", font=("Helvetica", 10), fill="yellow")

def gizemC():
    depthmapXcli = "C:/depthmapXcli_win64.exe"

    coord = clientPx + "," + clientPy + "," + "90" + "," + "120"

    text_file = open("depthmapXcli_commands.txt", "w")

    text_file.write(subprocess.check_output([depthmapXcli, "-h"]).decode("utf-8"))

    subprocess.check_output([depthmapXcli,
                             "-f",  filePNG,
                             "-o",  "C:/temp/out.graph",
                             "-m",  "ISOVIST",
                             "-ii", coord,])

    subprocess.check_output([depthmapXcli, "-f", "C:/temp/out.graph", "-o", "C:/temp/out.graph", "-m", "MAPCONVERT", "-cp", "convex", "-con", "

    subprocess.check_output([depthmapXcli, "-f", "C:/temp/out.graph", "-o", "C:/temp/out.mif", "-m", "EXPORT", "-em", "shapegraph-map-mif"])

    os.remove("C:/temp/out.graph")

    isovists = geopandas.read_file("C:/temp/out.mif")
    isovists.crs = ''
    os.remove("C:/temp/out.mif")
    os.remove("C:/temp/out.mid")

    galleryPlan = geopandas.read_file(filePNG)
    galleryPlan.crs = ''

    fig, ax = plt.subplots(figsize=(20, 10))
    ax.axis('off')
    ax.set_aspect('equal')
    galleryPlan.plot(ax=ax, edgecolor='black')
    isovists.plot(ax=ax, edgecolor='black')

    startX = pointX
    startY = pointY
    point_matrix = [[startX + x * intervalA, startY + y * intervalA] for x in range(int(rangeX)) for y in range(int(rangeY))]

    gallery_points = geopandas.GeoDataFrame(geometry=geopandas.points_from_xy(x=[item[0] for item in point_matrix], y=[item[1] for item in point
    gallery_points.crs = ''

    point_in_isovist = np.transpose(isovists.apply(lambda row: gallery_points.intersects(isovists.loc[[row.name]].unary_union), axis=1))
    point_in_isovist.columns = "in_isovist_" + isovists['Depthmap Ref'].map(str)
    point_in_isovist['which_isovist'] = point_in_isovist.eq(True).dot(point_in_isovist.columns)
    gallery_points = gallery_points.join(point_in_isovist)

    fig, ax = plt.subplots(figsize=(15, 5))
    ax.axis('off')
    ax.set_aspect('equal')
    isovists.plot(ax=ax, edgecolor='black')
    gallery_points.plot(ax=ax, edgecolor='black', column='which_isovist', markersize = 50)
```

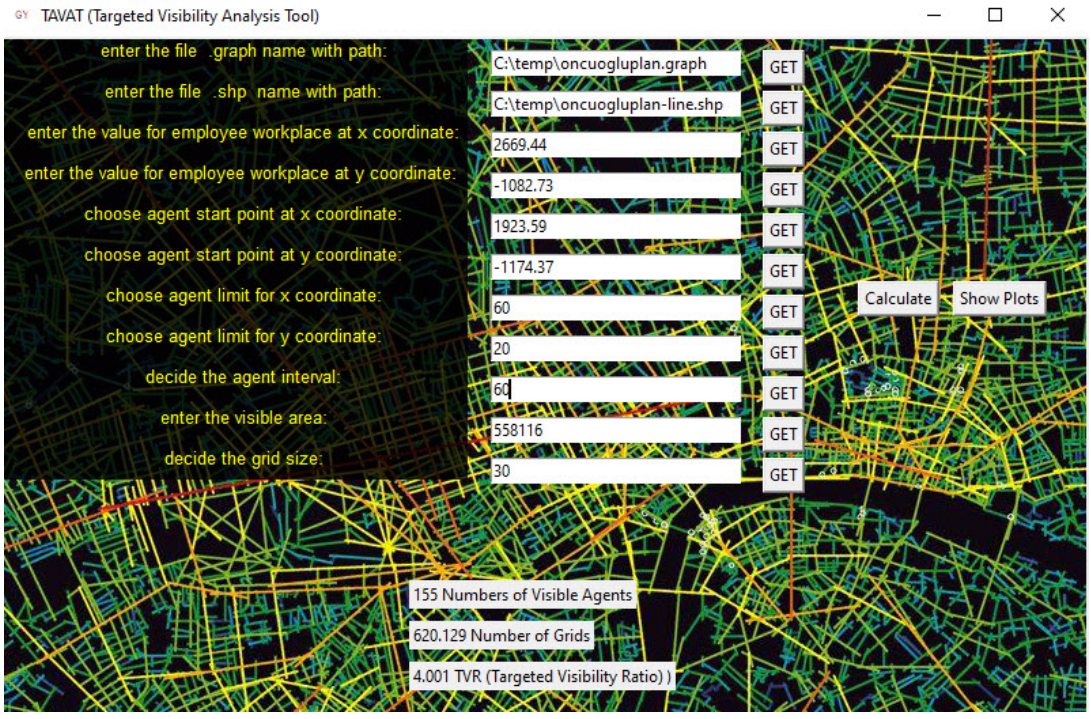
```
fig, ax = plt.subplots(figsize=(20, 10))
ax.axis('off')
ax.set_aspect('equal')
galleryPlan.plot(ax=ax, edgecolor='black')
isovists.plot(ax=ax, edgecolor='black')
gallery_points.plot(ax=ax, edgecolor='black', column='which_isovist', markersize = 20)
gallery_points.to_csv('file_name.csv', index=False)

insidePoint=0;

with open('file_name.csv', 'r') as read_obj:
    csv_reader = reader(read_obj)
    header = next(csv_reader)
    if header != None:
        for row in csv_reader:
            if row.__contains__("True"):
                insidePoint= insidePoint + 1

gridArea= gridSize*gridSize
gridNumber=visibilityArea2/gridArea
print(insidePoint,"agent can be seen from the view of client")
gizemConstant=gridNumber/insidePoint
print(gridNumber,"is grid number")
print(gizemConstant,"is gizemConstant")
gA=str(gridArea)
iPo=str(insidePoint)
gN=str(gridNumber)
gCns=str(gizemConstant)


gN2= gN + " is grid number"
iPo2=iPo + " agent can be seen from the view of client"
gCns2=gCns + " is gizemConstant"
viewableAgent=Label(root,text=iPo2)
#viewableAgent.pack()
viewableAgent.place(x=300,y=400)
gNum=Label(root,text=gN2)
#gNum.pack()
gNum.place(x=300,y=430)
    gN2= gN + " is grid number"
    iPo2=iPo + " agent can be seen from the view of client"
    gCns2=gCns + " is gizemConstant"
    viewableAgent=Label(root,text=iPo2)
    #viewableAgent.pack()
    viewableAgent.place(x=300,y=400)
    gNum=Label(root,text=gN2)
    #gNum.pack()
    gNum.place(x=300,y=430)
    gCon=Label(root,text=gCns2)
    #gCon.pack()
    gCon.place(x=300,y=460)

myButton12 = Button(root, text="Calculate", command=gizemC)
#myButton12.pack()
```

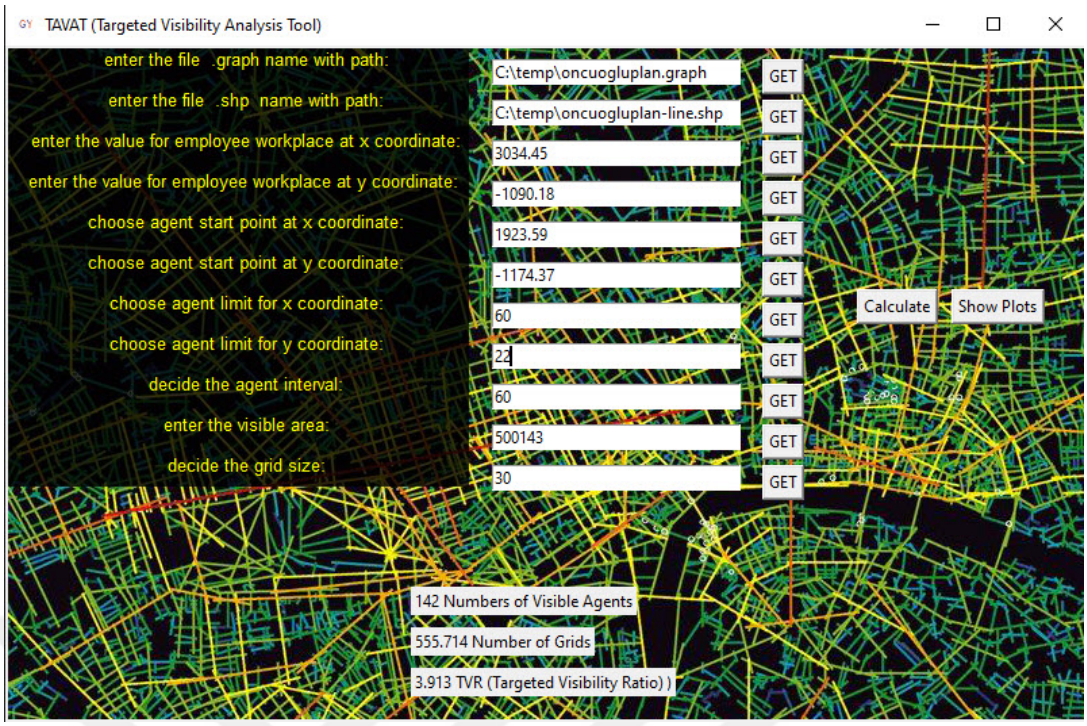
Appendix F. Targeted Visibility Ratio Outputs for Öncüoğlu Architects

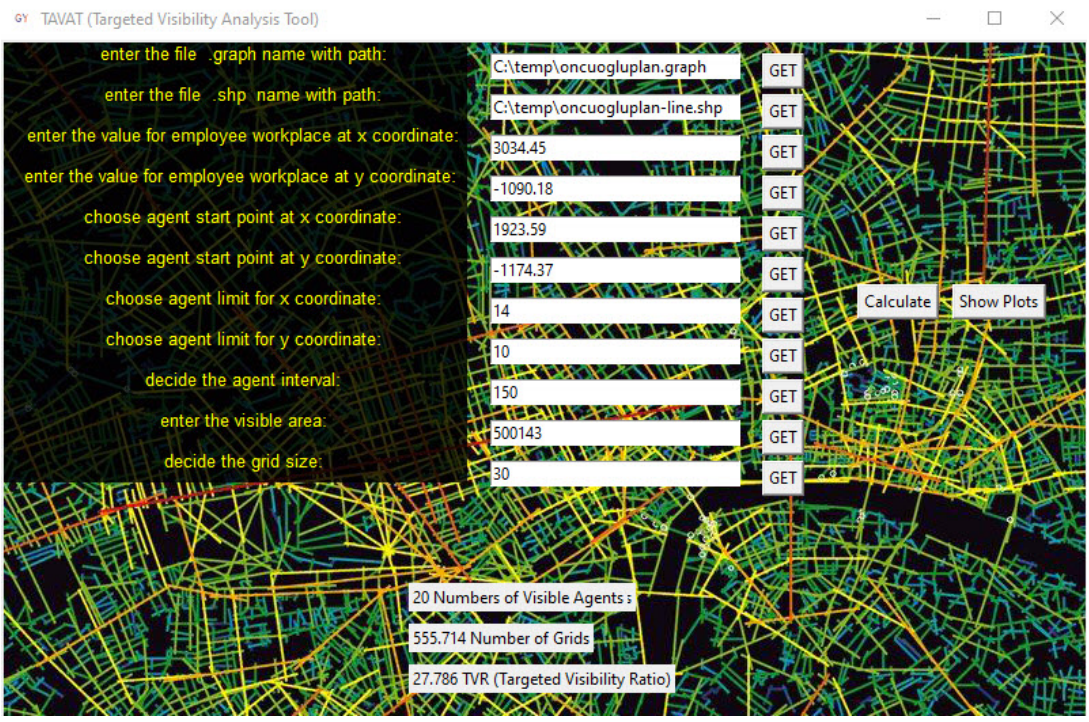


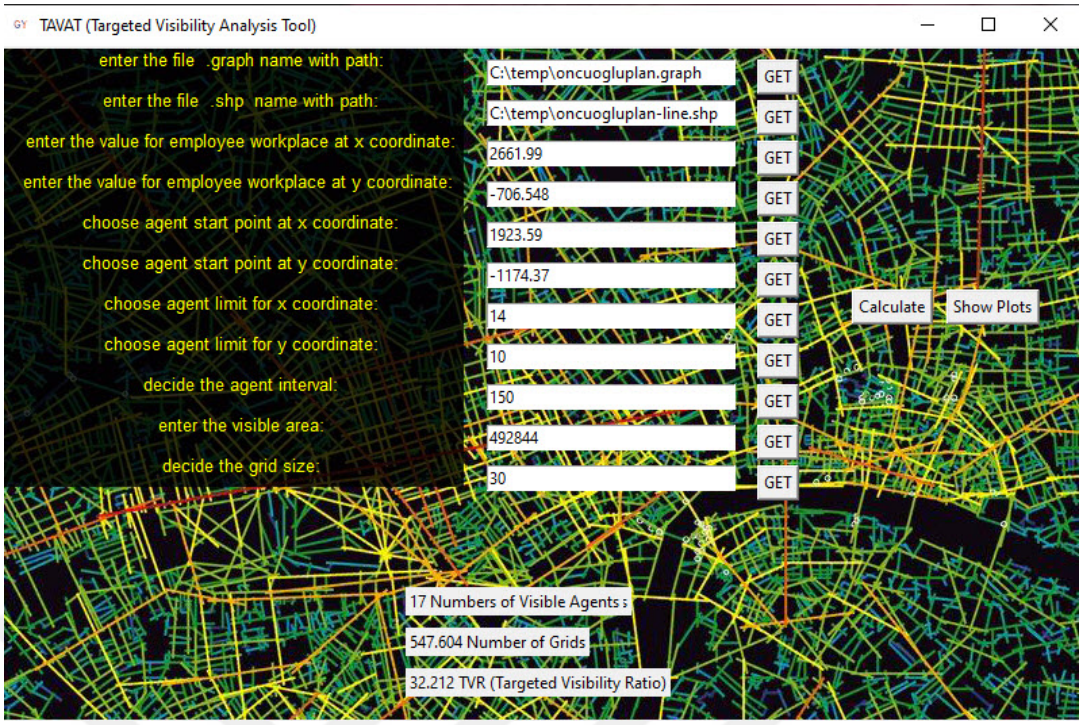


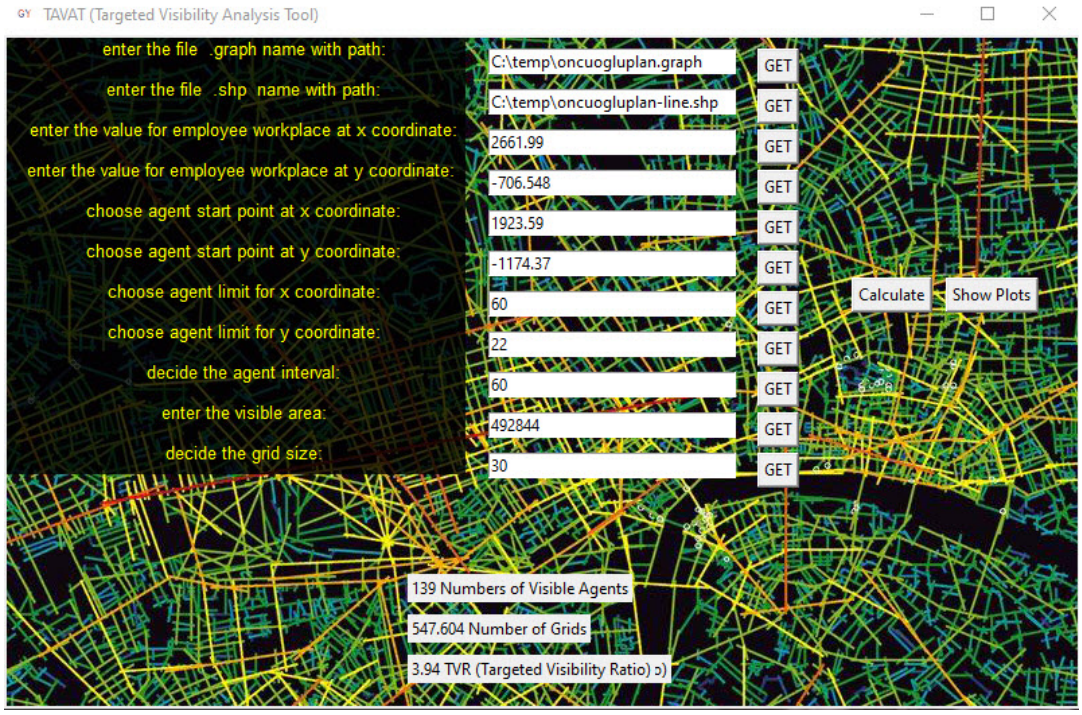

TAVAT (Targeted Visibility Analysis Tool)
enter the file .graph name with path:
enter the file .shp name with path:
enter the value for employee workplace at x coordinate:
enter the value for employee workplace at y coordinate:
choose agent start point at x coordinate:
choose agent start point at y coordinate:
choose agent limit for x coordinate:
choose agent limit for y coordinate:
decide the agent interval:
enter the visible area:
decide the grid size:
C:\temp\oncuogluplan.graph
C:\temp\oncuogluplan-line.shp
2669.44
-1082.73
1923.59
-1174.37
14
6
150
558116
30
GET
Calculate
Show Plots
22 Numbers of Visible Agents s
620.129 Number of Grids
28.188 TVR (Targeted Visibility Ratio)

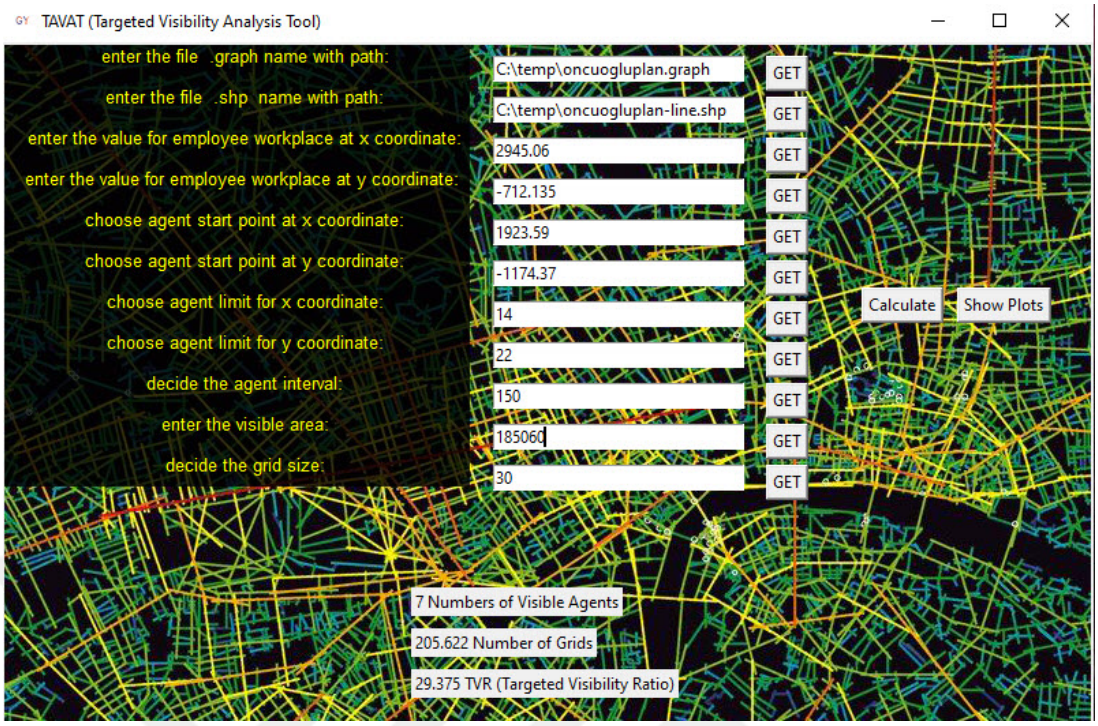

TAVAT (Targeted Visibility Analysis Tool)
enter the file .graph name with path:
enter the file .shp name with path:
enter the value for employee workplace at x coordinate:
enter the value for employee workplace at y coordinate:
choose agent start point at x coordinate:
choose agent start point at y coordinate:
choose agent limit for x coordinate:
choose agent limit for y coordinate:
decide the agent interval:
enter the visible area:
decide the grid size:
C:\temp\oncuogluplan.graph
C:\temp\oncuogluplan-line.shp
2669.44
-1082.73
1923.59
-1174.37
60
20
60
558116
30
GET
Calculate
Show Plots
155 Numbers of Visible Agents
620.129 Number of Grids
4.001 TVR (Targeted Visibility Ratio))

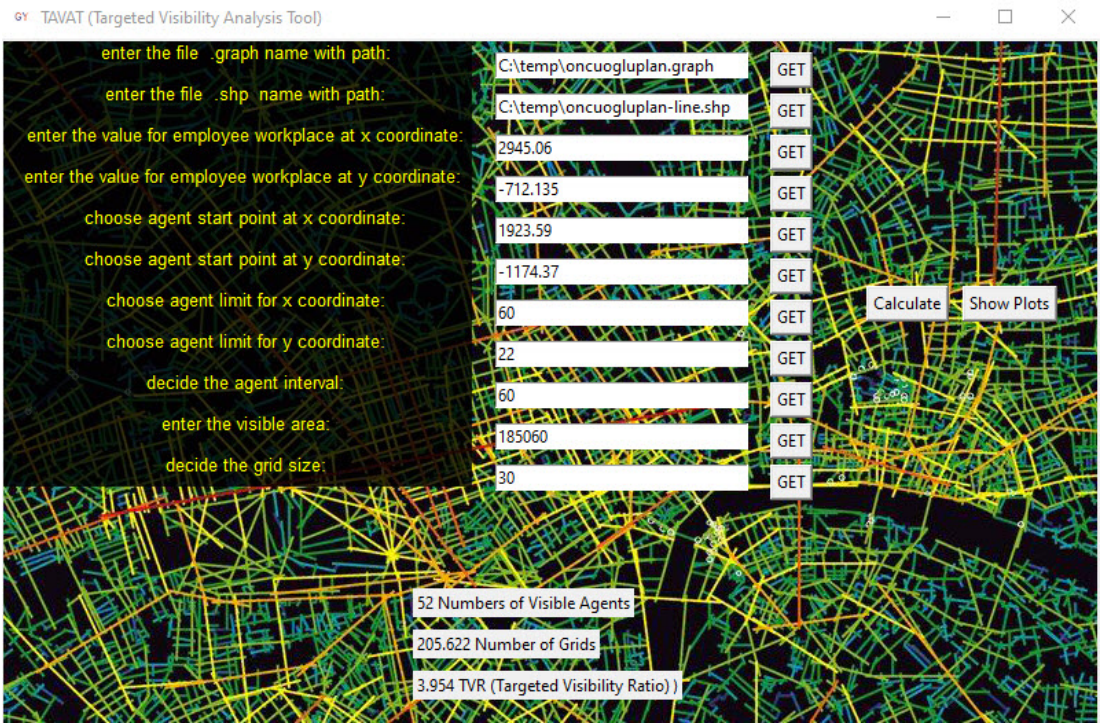

TAVAT (Targeted Visibility Analysis Tool)
enter the file .graph name with path:
enter the file .shp name with path:
enter the value for employee workplace at x coordinate:
enter the value for employee workplace at y coordinate:
choose agent start point at x coordinate:
choose agent start point at y coordinate:
choose agent limit for x coordinate:
choose agent limit for y coordinate:
decide the agent interval:
enter the visible area:
decide the grid size:
C:\temp\oncuogluplan.graph
C:\temp\oncuogluplan-line.shp
3034.45
-1090.18
1923.59
-1174.37
60
22
60
500143
30
GET
Calculate
Show Plots
142 Numbers of Visible Agents
555.714 Number of Grids
3.913 TVR (Targeted Visibility Ratio))

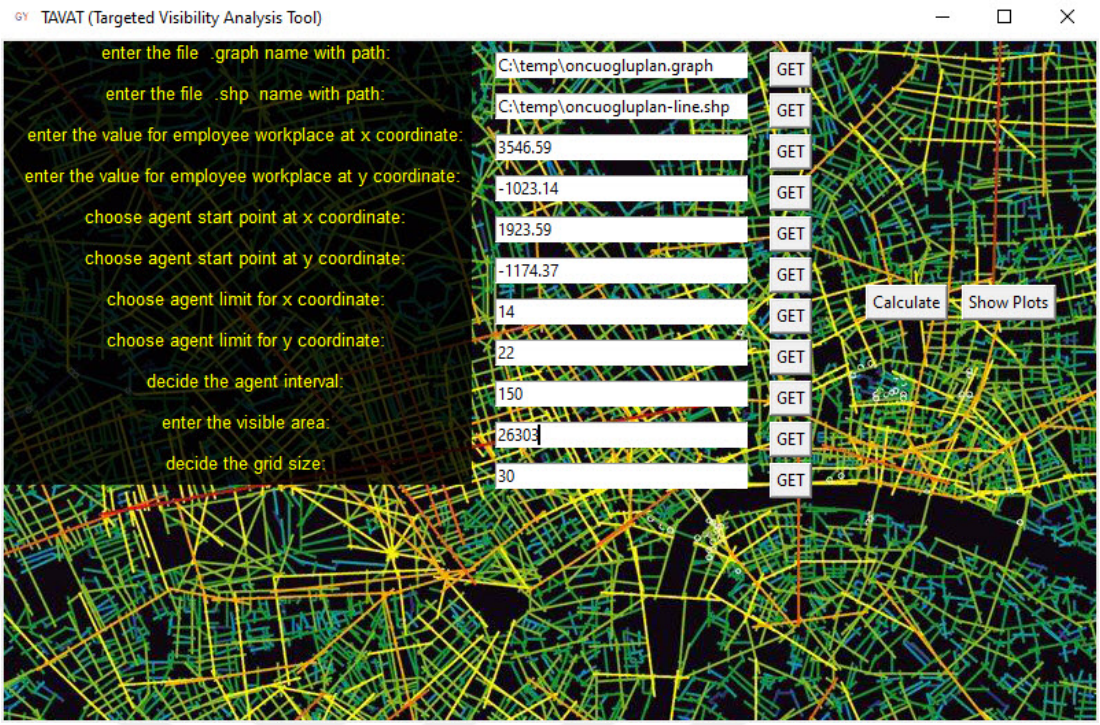

TAVAT (Targeted Visibility Analysis Tool)
enter the file .graph name with path:
enter the file .shp name with path:
enter the value for employee workplace at x coordinate:
enter the value for employee workplace at y coordinate:
choose agent start point at x coordinate:
choose agent start point at y coordinate:
choose agent limit for x coordinate:
choose agent limit for y coordinate:
decide the agent interval:
enter the visible area:
decide the grid size:
C:\temp\oncuogluplan.graph
C:\temp\oncuogluplan-line.shp
3034.45
-1090.18
1923.59
-1174.37
14
10
150
500143
30
GET
Calculate
Show Plots
20 Numbers of Visible Agents s
555.714 Number of Grids
27.786 TVR (Targeted Visibility Ratio)

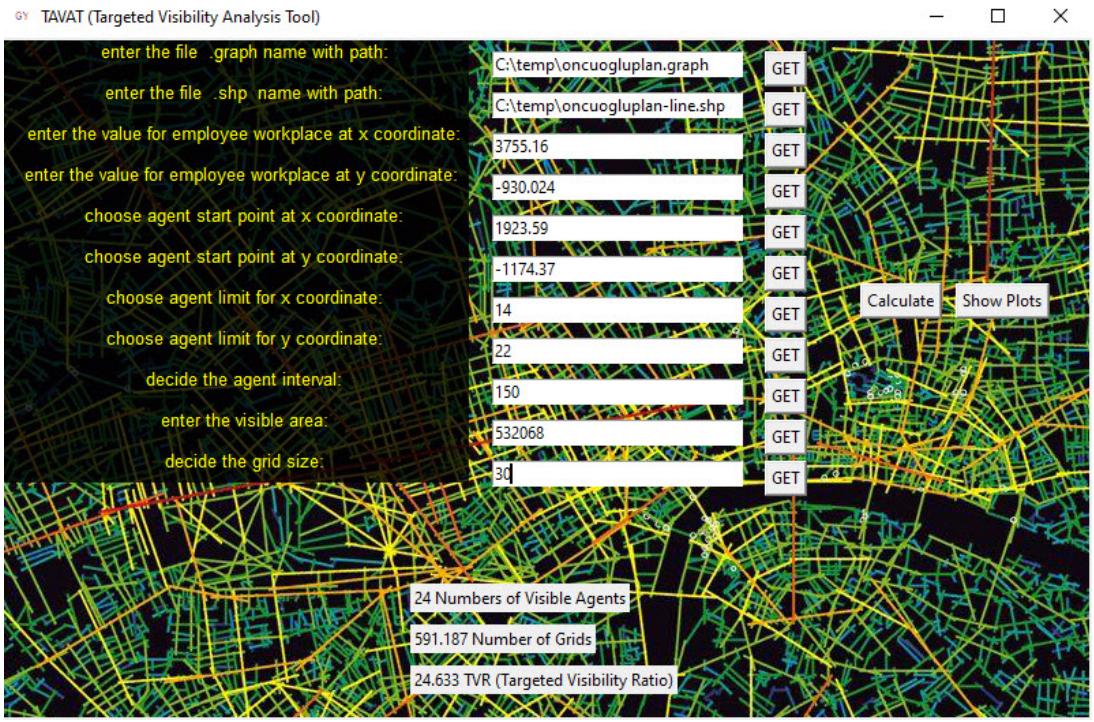

TAVAT (Targeted Visibility Analysis Tool)
enter the file .graph name with path:
enter the file .shp name with path:
enter the value for employee workplace at x coordinate:
enter the value for employee workplace at y coordinate:
choose agent start point at x coordinate:
choose agent start point at y coordinate:
choose agent limit for x coordinate:
choose agent limit for y coordinate:
decide the agent interval:
enter the visible area:
decide the grid size:
C:\temp\oncuogluplan.graph
C:\temp\oncuogluplan-line.shp
2661.99
-706.548
1923.59
-1174.37
14
10
150
492844
30
GET
Calculate
Show Plots
17 Numbers of Visible Agents
547.604 Number of Grids
32.212 TVR (Targeted Visibility Ratio)

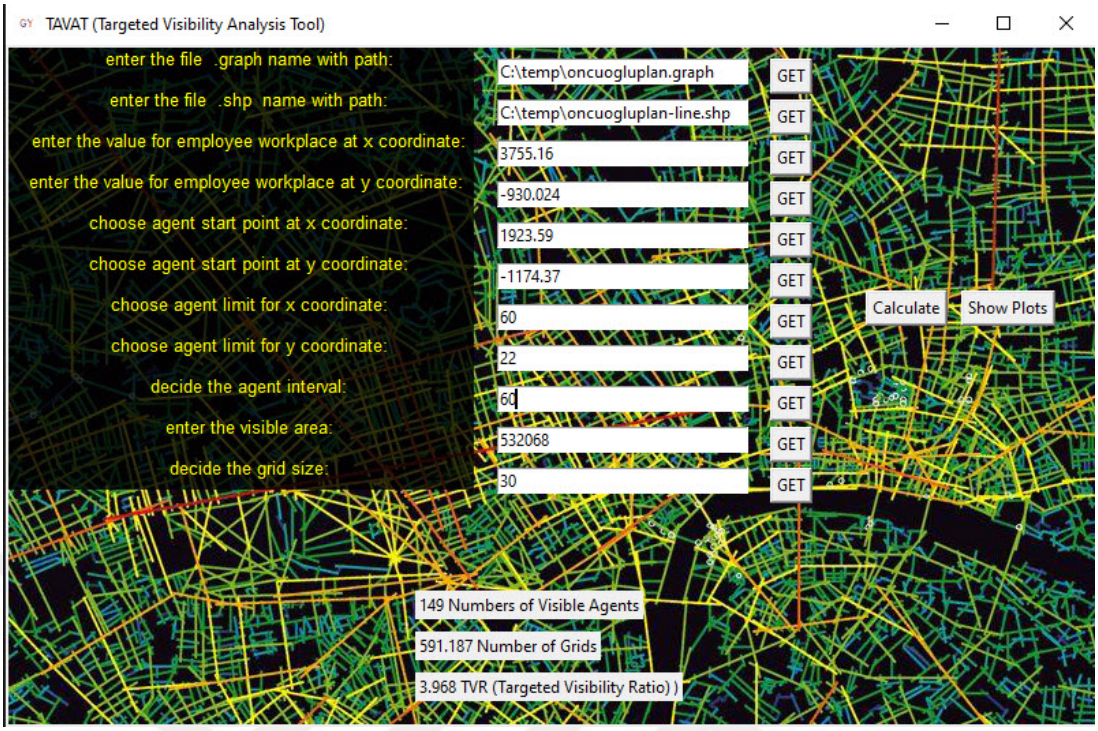

TAVAT (Targeted Visibility Analysis Tool)
enter the file .graph name with path:
enter the file .shp name with path:
enter the value for employee workplace at x coordinate:
enter the value for employee workplace at y coordinate:
choose agent start point at x coordinate:
choose agent start point at y coordinate:
choose agent limit for x coordinate:
choose agent limit for y coordinate:
decide the agent interval:
enter the visible area:
decide the grid size:
C:\temp\oncuogluplan.graph
C:\temp\oncuogluplan-line.shp
2661.99
-706.548
1923.59
-1174.37
60
22
60
492844
30
GET
Calculate
Show Plots
139 Numbers of Visible Agents
547.604 Number of Grids
3.94 TVR (Targeted Visibility Ratio)

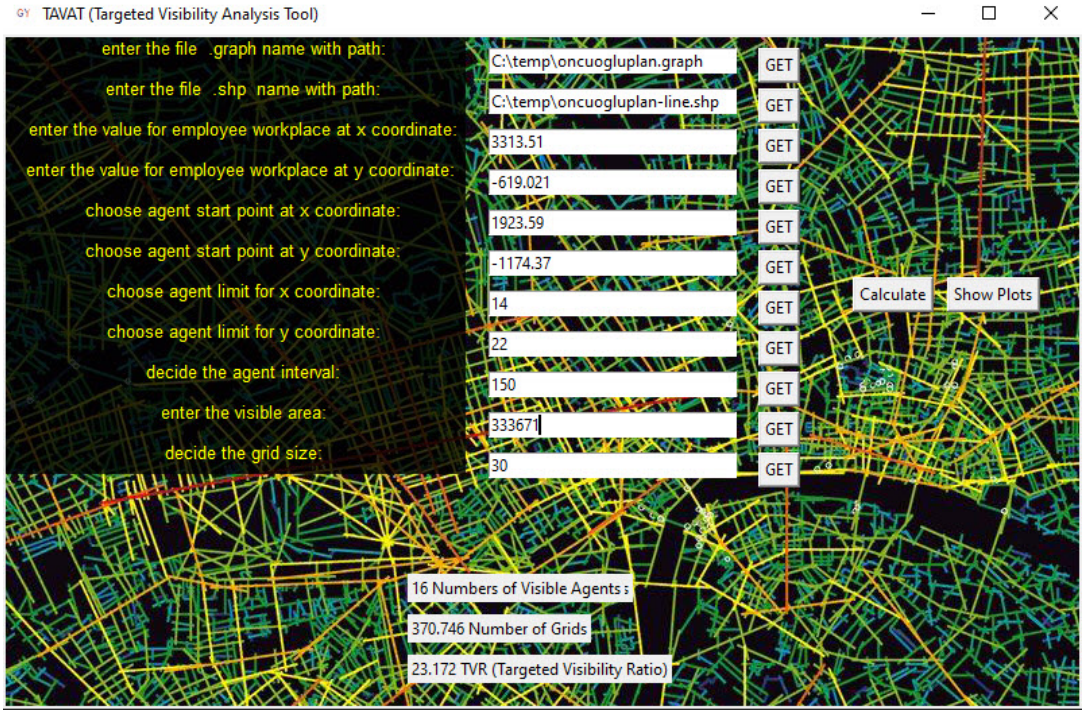

TAVAT (Targeted Visibility Analysis Tool)
enter the file .graph name with path:
enter the file .shp name with path:
enter the value for employee workplace at x coordinate:
enter the value for employee workplace at y coordinate:
choose agent start point at x coordinate:
choose agent start point at y coordinate:
choose agent limit for x coordinate:
choose agent limit for y coordinate:
decide the agent interval:
enter the visible area:
decide the grid size:
C:\temp\oncuogluplan.graph
C:\temp\oncuogluplan-line.shp
2945.06
-712.135
1923.59
-1174.37
14
22
150
185060
30
GET
Calculate
Show Plots
7 Numbers of Visible Agents
205.622 Number of Grids
29.375 TVR (Targeted Visibility Ratio)

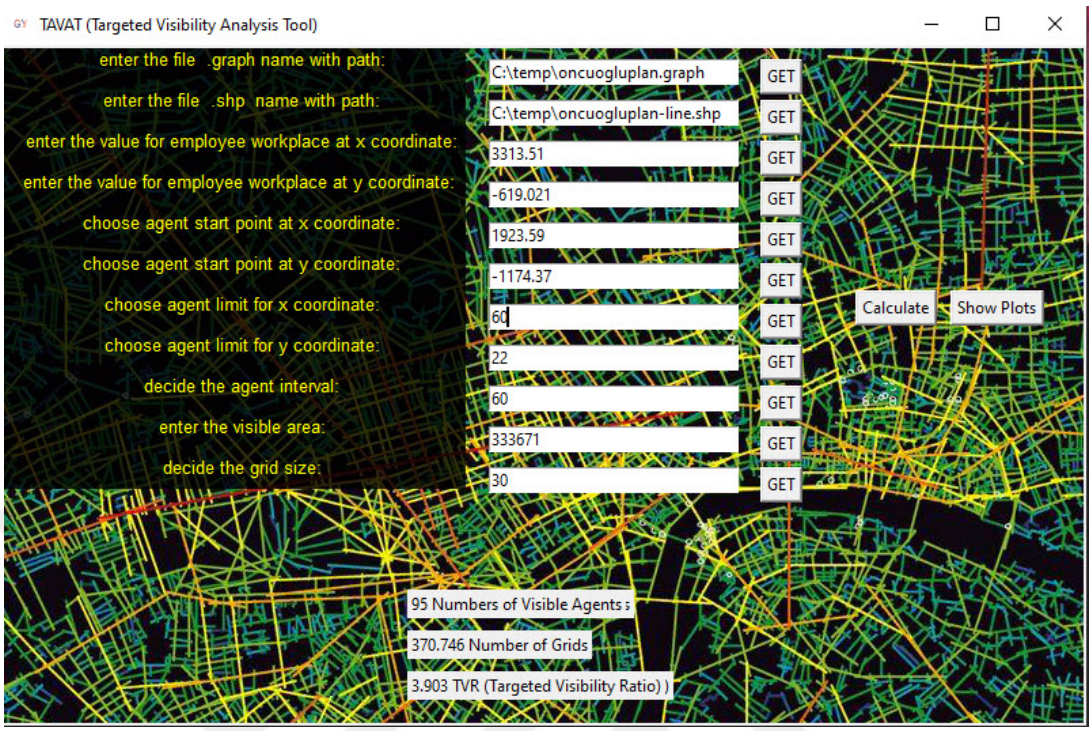

TAVAT (Targeted Visibility Analysis Tool)
enter the file .graph name with path:
enter the file .shp name with path:
enter the value for employee workplace at x coordinate:
enter the value for employee workplace at y coordinate:
choose agent start point at x coordinate:
choose agent start point at y coordinate:
choose agent limit for x coordinate:
choose agent limit for y coordinate:
decide the agent interval:
enter the visible area:
decide the grid size:
C:\temp\oncuogluplan.graph
C:\temp\oncuogluplan-line.shp
2945.06
-712.135
1923.59
-1174.37
60
22
60
185060
30
GET
Calculate
Show Plots
52 Numbers of Visible Agents
205.622 Number of Grids
3.954 TVR (Targeted Visibility Ratio))

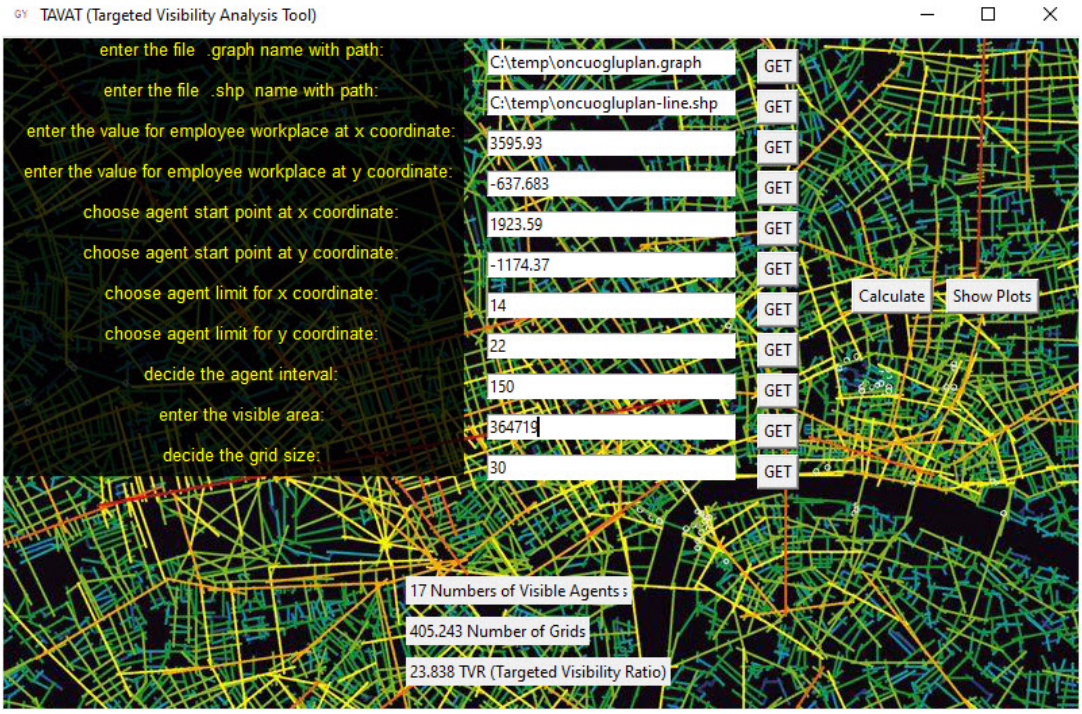

TAVAT (Targeted Visibility Analysis Tool)
enter the file .graph name with path:
enter the file .shp name with path:
enter the value for employee workplace at x coordinate:
enter the value for employee workplace at y coordinate:
choose agent start point at x coordinate:
choose agent start point at y coordinate:
choose agent limit for x coordinate:
choose agent limit for y coordinate:
decide the agent interval:
enter the visible area:
decide the grid size:
C:\temp\oncuogluplan.graph
C:\temp\oncuogluplan-line.shp
3546.59
-1023.14
1923.59
-1174.37
14
22
150
26303
30
GET
Calculate
Show Plots

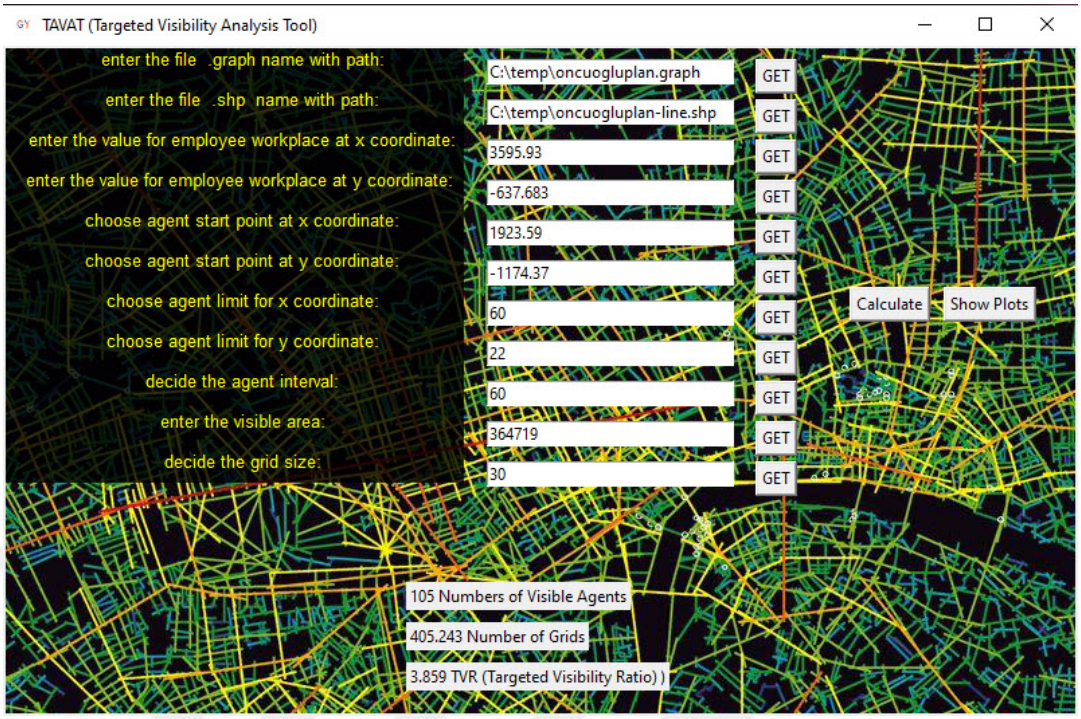

TAVAT (Targeted Visibility Analysis Tool)
enter the file .graph name with path:
enter the file .shp name with path:
enter the value for employee workplace at x coordinate:
enter the value for employee workplace at y coordinate:
choose agent start point at x coordinate:
choose agent start point at y coordinate:
choose agent limit for x coordinate:
choose agent limit for y coordinate:
decide the agent interval:
enter the visible area:
decide the grid size:
C:\temp\oncuogluplan.graph
C:\temp\oncuogluplan-line.shp
3755.16
-930.024
1923.59
-1174.37
14
22
150
532068
30
GET
Calculate
Show Plots
24 Numbers of Visible Agents
591.187 Number of Grids
24.633 TVR (Targeted Visibility Ratio)

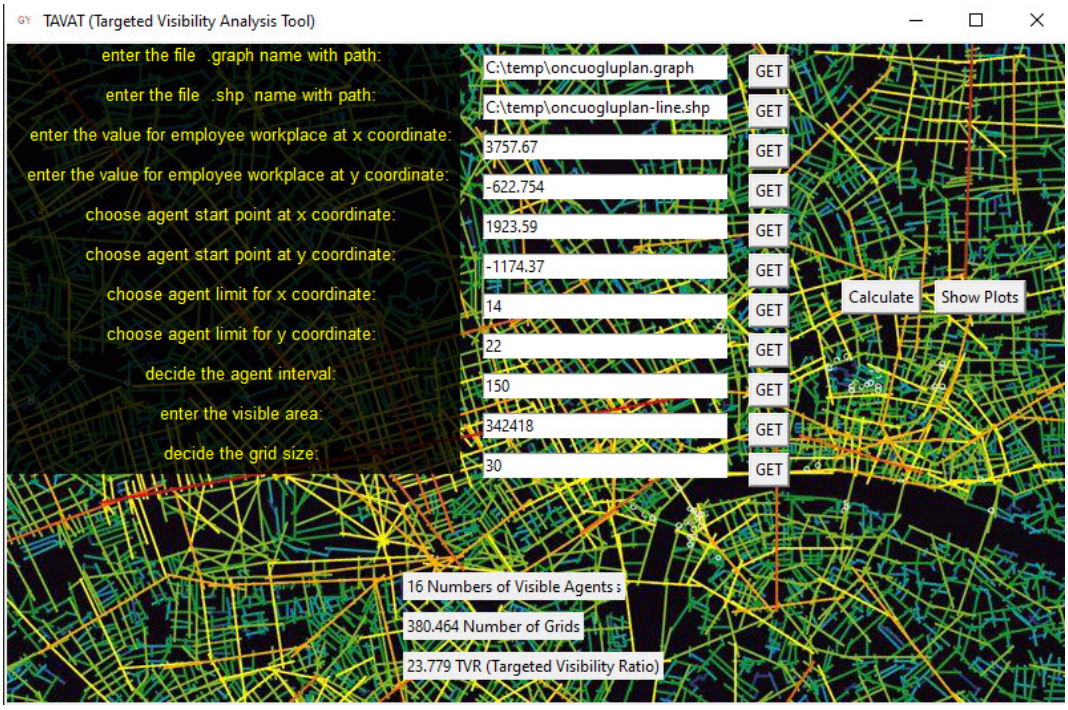

TAVAT (Targeted Visibility Analysis Tool)
enter the file .graph name with path:
enter the file .shp name with path:
enter the value for employee workplace at x coordinate:
enter the value for employee workplace at y coordinate:
choose agent start point at x coordinate:
choose agent start point at y coordinate:
choose agent limit for x coordinate:
choose agent limit for y coordinate:
decide the agent interval:
enter the visible area:
decide the grid size:
C:\temp\oncuogluplan.graph
C:\temp\oncuogluplan-line.shp
3755.16
-930.024
1923.59
-1174.37
60
22
60
532068
30
GET
Calculate
Show Plots
149 Numbers of Visible Agents
591.187 Number of Grids
3.968 TVR (Targeted Visibility Ratio))

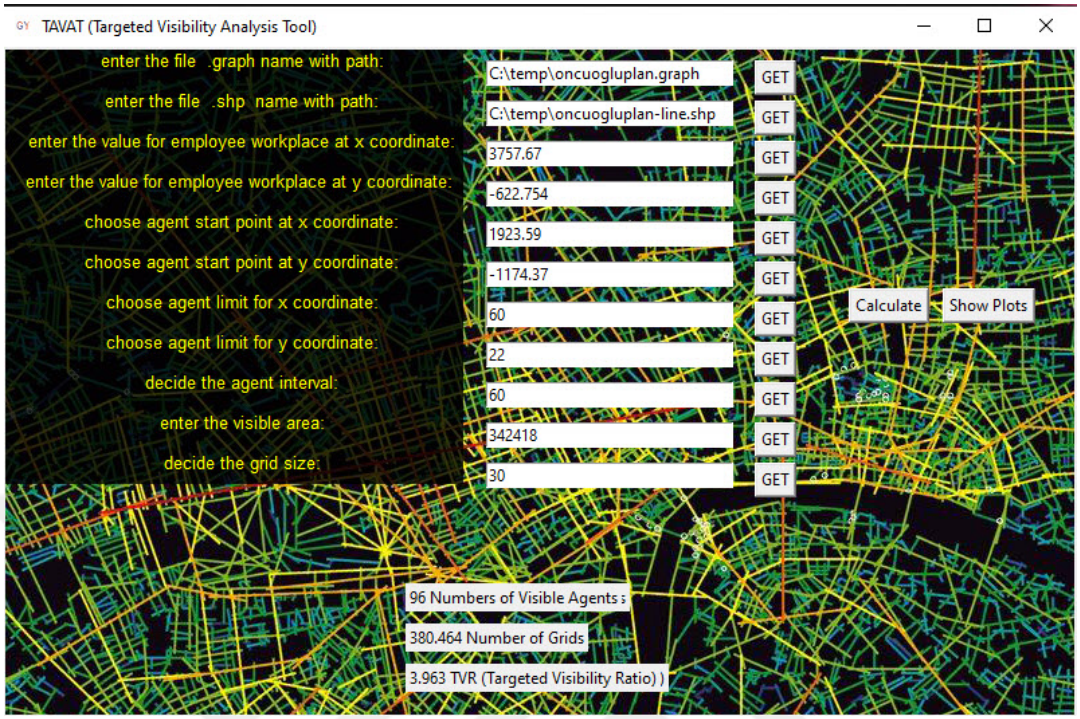

TAVAT (Targeted Visibility Analysis Tool)
enter the file .graph name with path:
enter the file .shp name with path:
enter the value for employee workplace at x coordinate:
enter the value for employee workplace at y coordinate:
choose agent start point at x coordinate:
choose agent start point at y coordinate:
choose agent limit for x coordinate:
choose agent limit for y coordinate:
decide the agent interval:
enter the visible area:
decide the grid size:
C:\temp\oncuogluplan.graph
C:\temp\oncuogluplan-line.shp
3313.51
-619.021
1923.59
-1174.37
14
22
150
333671
30
GET
Calculate
Show Plots
16 Numbers of Visible Agents s
370.746 Number of Grids
23.172 TVR (Targeted Visibility Ratio)

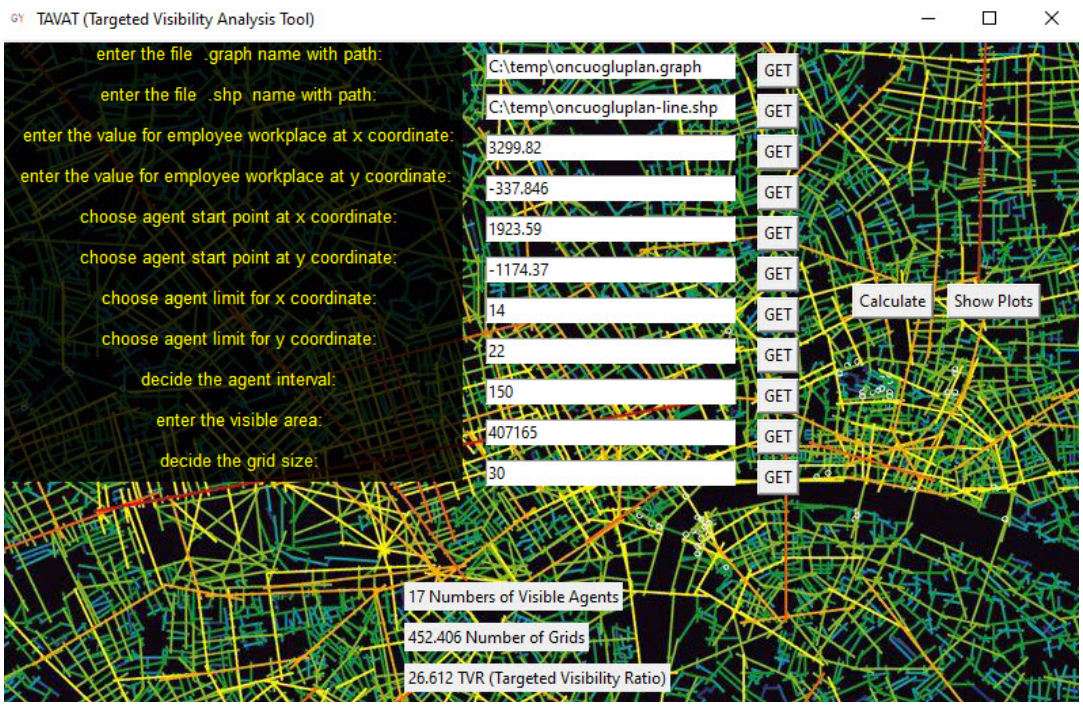

TAVAT (Targeted Visibility Analysis Tool)
enter the file .graph name with path:
enter the file .shp name with path:
enter the value for employee workplace at x coordinate:
enter the value for employee workplace at y coordinate:
choose agent start point at x coordinate:
choose agent start point at y coordinate:
choose agent limit for x coordinate:
choose agent limit for y coordinate:
decide the agent interval:
enter the visible area:
decide the grid size:
C:\temp\oncuogluplan.graph
C:\temp\oncuogluplan-line.shp
3313.51
-619.021
1923.59
-1174.37
60
22
60
333671
30
GET
Calculate
Show Plots
95 Numbers of Visible Agents :
370.746 Number of Grids
3.903 TVR (Targeted Visibility Ratio))

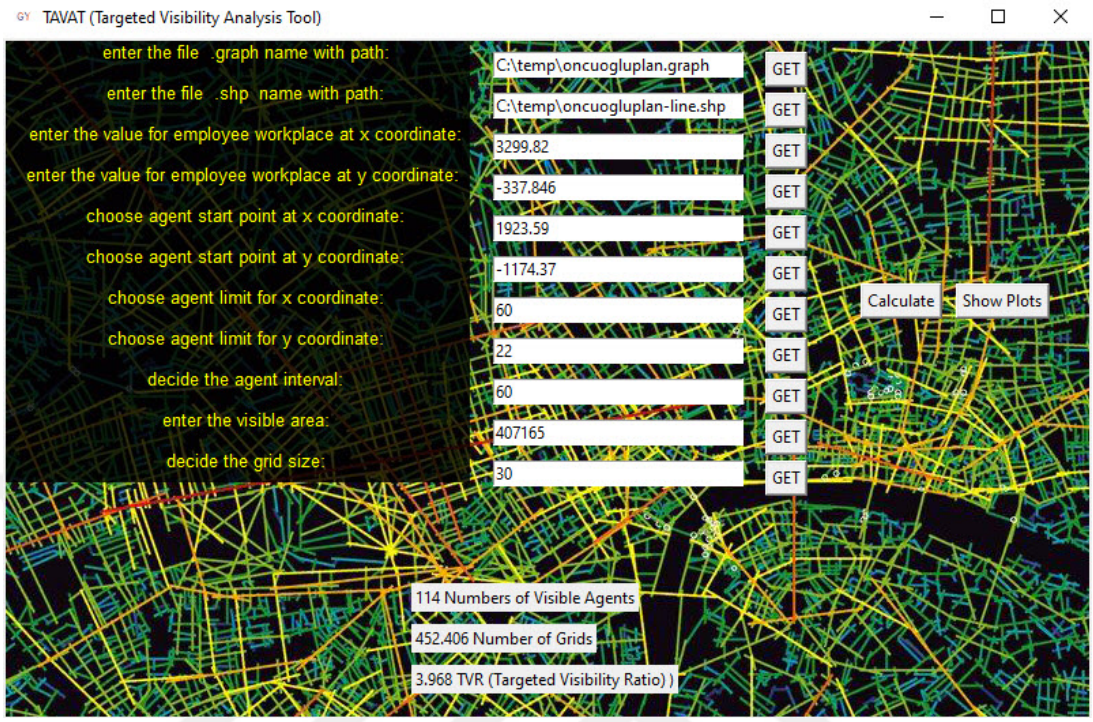

TAVAT (Targeted Visibility Analysis Tool)
enter the file .graph name with path:
enter the file .shp name with path:
enter the value for employee workplace at x coordinate:
enter the value for employee workplace at y coordinate:
choose agent start point at x coordinate:
choose agent start point at y coordinate:
choose agent limit for x coordinate:
choose agent limit for y coordinate:
decide the agent interval:
enter the visible area:
decide the grid size:
C:\temp\oncuogluplan.graph
C:\temp\oncuogluplan-line.shp
3595.93
-637.683
1923.59
-1174.37
14
22
150
364719
30
GET
Calculate
Show Plots
17 Numbers of Visible Agents :
405.243 Number of Grids
23.838 TVR (Targeted Visibility Ratio)

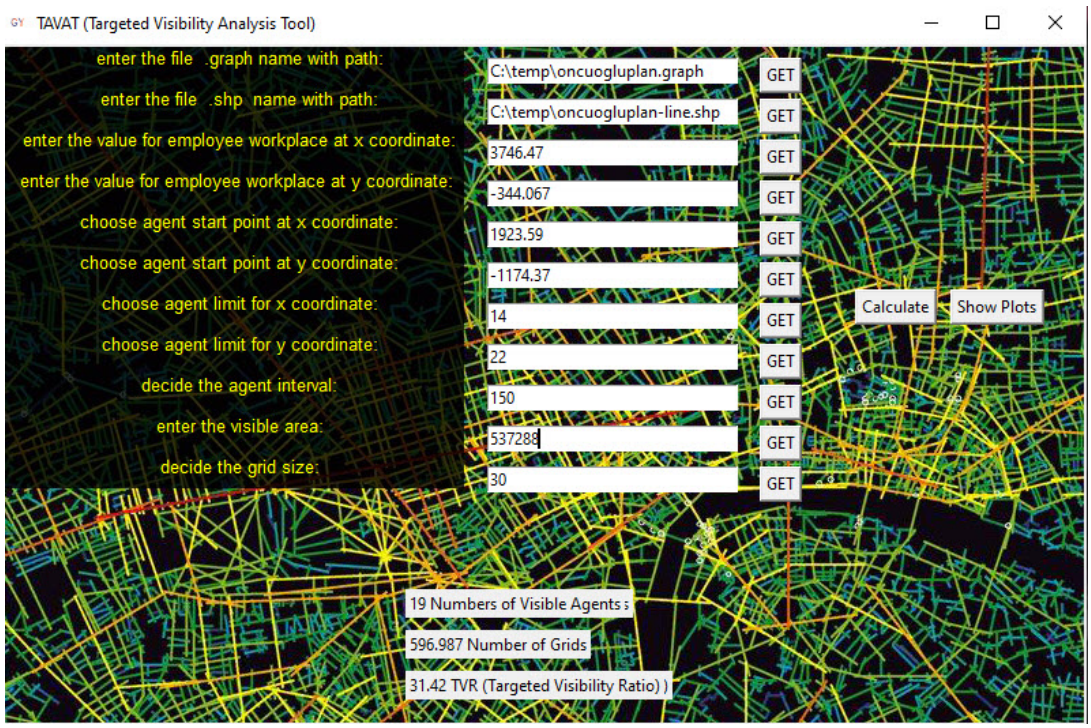

TAVAT (Targeted Visibility Analysis Tool)
enter the file .graph name with path:
enter the file .shp name with path:
enter the value for employee workplace at x coordinate:
enter the value for employee workplace at y coordinate:
choose agent start point at x coordinate:
choose agent start point at y coordinate:
choose agent limit for x coordinate:
choose agent limit for y coordinate:
decide the agent interval:
enter the visible area:
decide the grid size:
C:\temp\oncuogluplan.graph
C:\temp\oncuogluplan-line.shp
3595.93
-637.683
1923.59
-1174.37
60
22
60
364719
30
GET
Calculate
Show Plots
105 Numbers of Visible Agents
405.243 Number of Grids
3.859 TVR (Targeted Visibility Ratio))

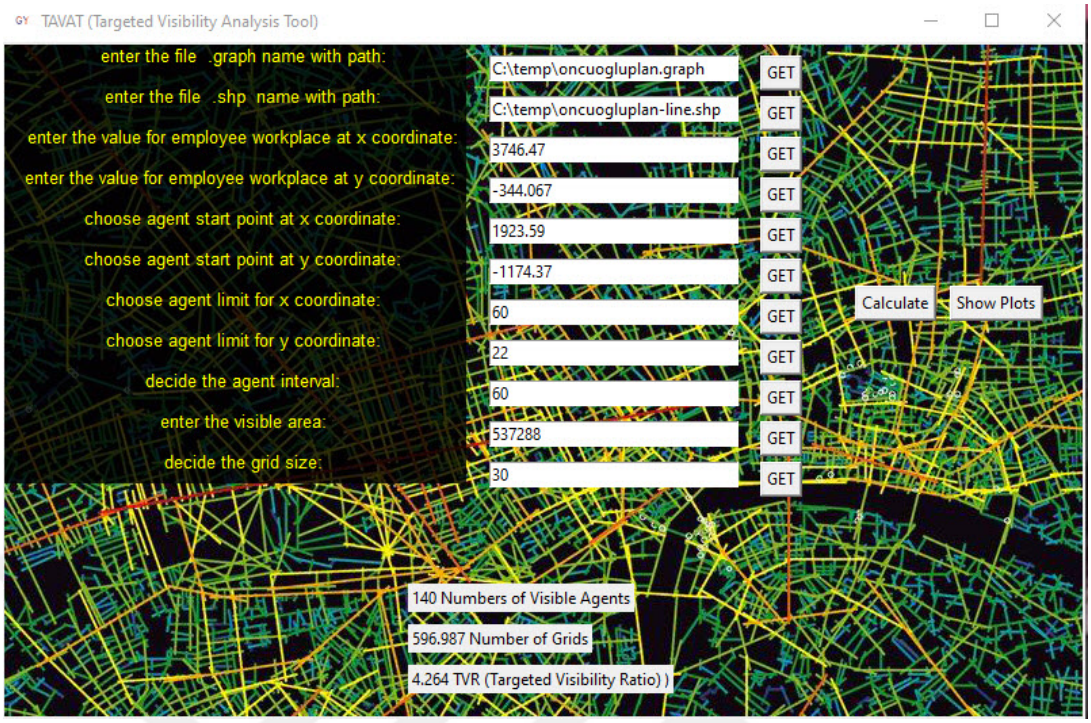

TAVAT (Targeted Visibility Analysis Tool)
enter the file .graph name with path:
enter the file .shp name with path:
enter the value for employee workplace at x coordinate:
enter the value for employee workplace at y coordinate:
choose agent start point at x coordinate:
choose agent start point at y coordinate:
choose agent limit for x coordinate:
choose agent limit for y coordinate:
decide the agent interval:
enter the visible area:
decide the grid size:
C:\temp\oncuogluplan.graph
C:\temp\oncuogluplan-line.shp
3757.67
-622.754
1923.59
-1174.37
14
22
150
342418
30
GET
Calculate
Show Plots
16 Numbers of Visible Agents s
380.464 Number of Grids
23.779 TVR (Targeted Visibility Ratio)

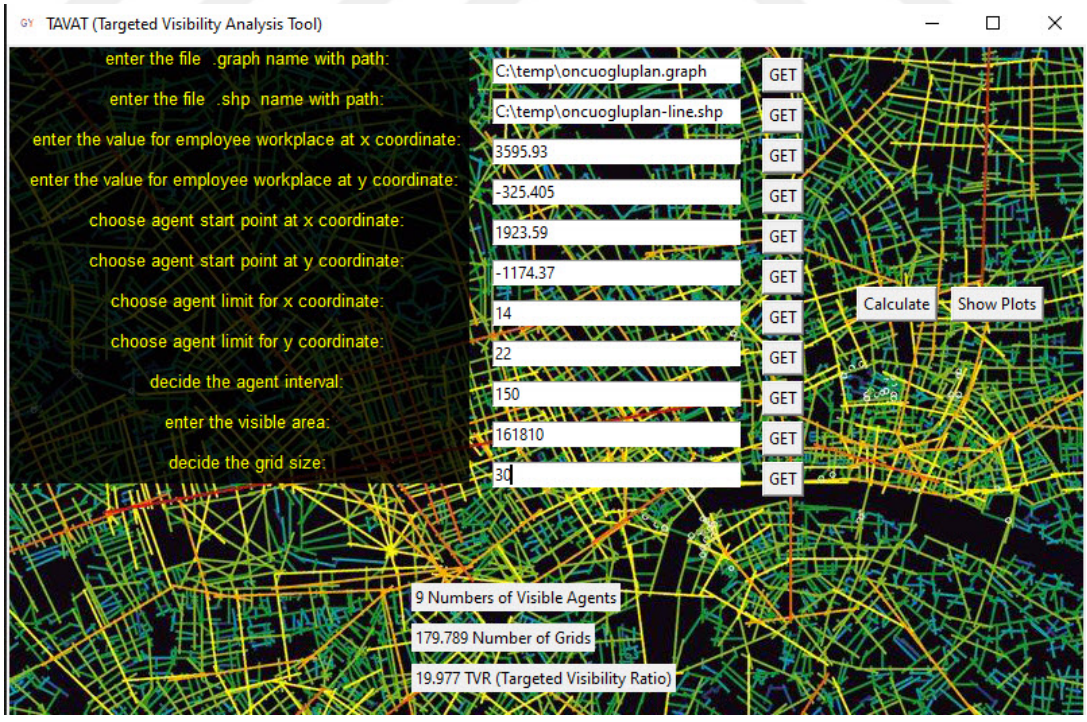

TAVAT (Targeted Visibility Analysis Tool)
enter the file .graph name with path:
enter the file .shp name with path:
enter the value for employee workplace at x coordinate:
enter the value for employee workplace at y coordinate:
choose agent start point at x coordinate:
choose agent start point at y coordinate:
choose agent limit for x coordinate:
choose agent limit for y coordinate:
decide the agent interval:
enter the visible area:
decide the grid size:
C:\temp\oncuogluplan.graph
C:\temp\oncuogluplan-line.shp
3757.67
-622.754
1923.59
-1174.37
60
22
60
342418
30
GET
Calculate
Show Plots
96 Numbers of Visible Agents s
380.464 Number of Grids
3.963 TVR (Targeted Visibility Ratio))

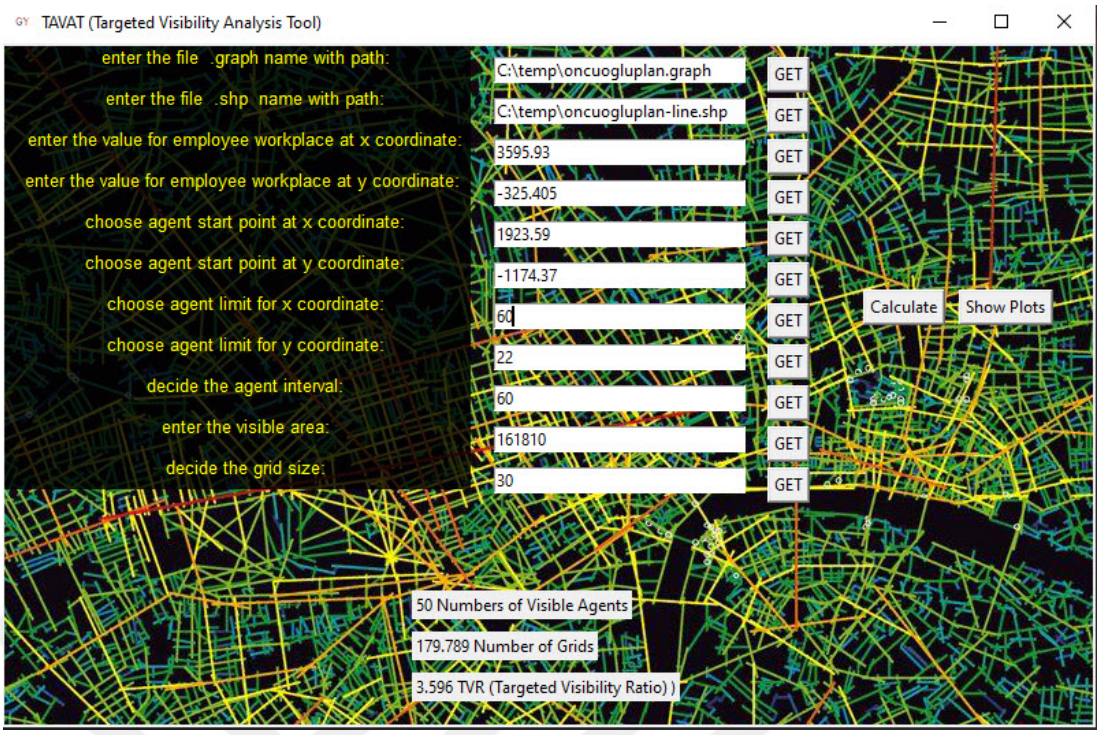

TAVAT (Targeted Visibility Analysis Tool)
enter the file .graph name with path:
enter the file .shp name with path:
enter the value for employee workplace at x coordinate:
enter the value for employee workplace at y coordinate:
choose agent start point at x coordinate:
choose agent start point at y coordinate:
choose agent limit for x coordinate:
choose agent limit for y coordinate:
decide the agent interval:
enter the visible area:
decide the grid size:
C:\temp\oncuogluplan.graph
C:\temp\oncuogluplan-line.shp
3299.82
-337.846
1923.59
-1174.37
14
22
150
407165
30
GET
Calculate
Show Plots
17 Numbers of Visible Agents
452.406 Number of Grids
26.612 TVR (Targeted Visibility Ratio)

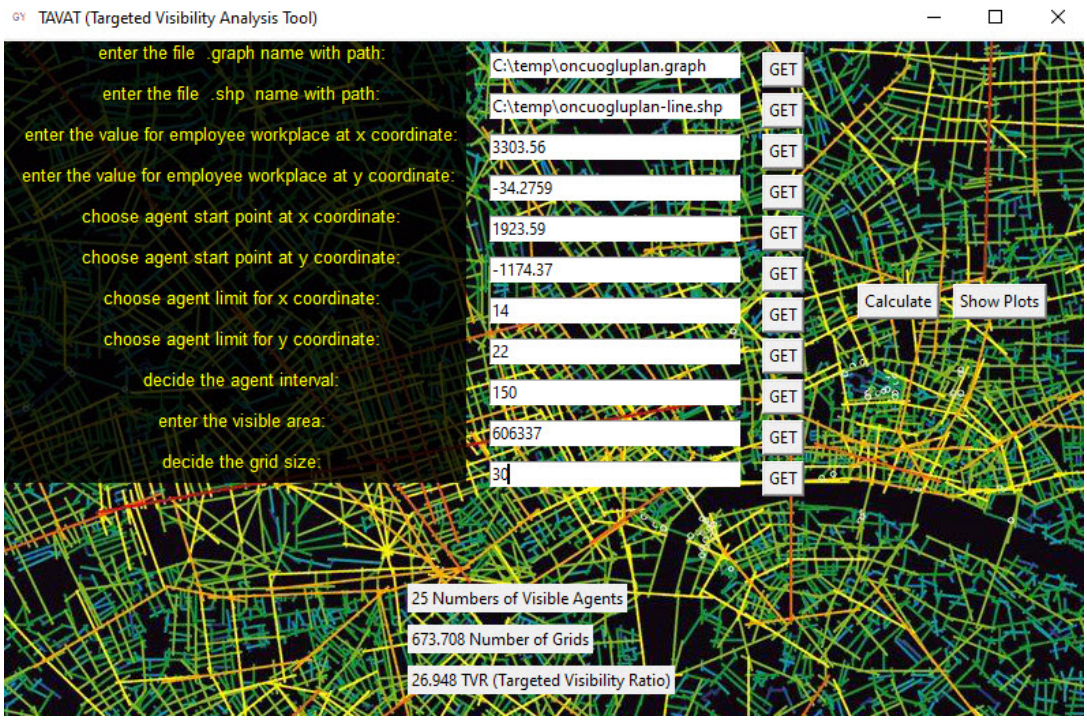

TAVAT (Targeted Visibility Analysis Tool)
enter the file .graph name with path:
enter the file .shp name with path:
enter the value for employee workplace at x coordinate:
enter the value for employee workplace at y coordinate:
choose agent start point at x coordinate:
choose agent start point at y coordinate:
choose agent limit for x coordinate:
choose agent limit for y coordinate:
decide the agent interval:
enter the visible area:
decide the grid size:
C:\temp\oncuogluplan.graph
C:\temp\oncuogluplan-line.shp
3299.82
-337.846
1923.59
-1174.37
60
22
60
407165
30
GET
Calculate
Show Plots
114 Numbers of Visible Agents
452.406 Number of Grids
3.968 TVR (Targeted Visibility Ratio))

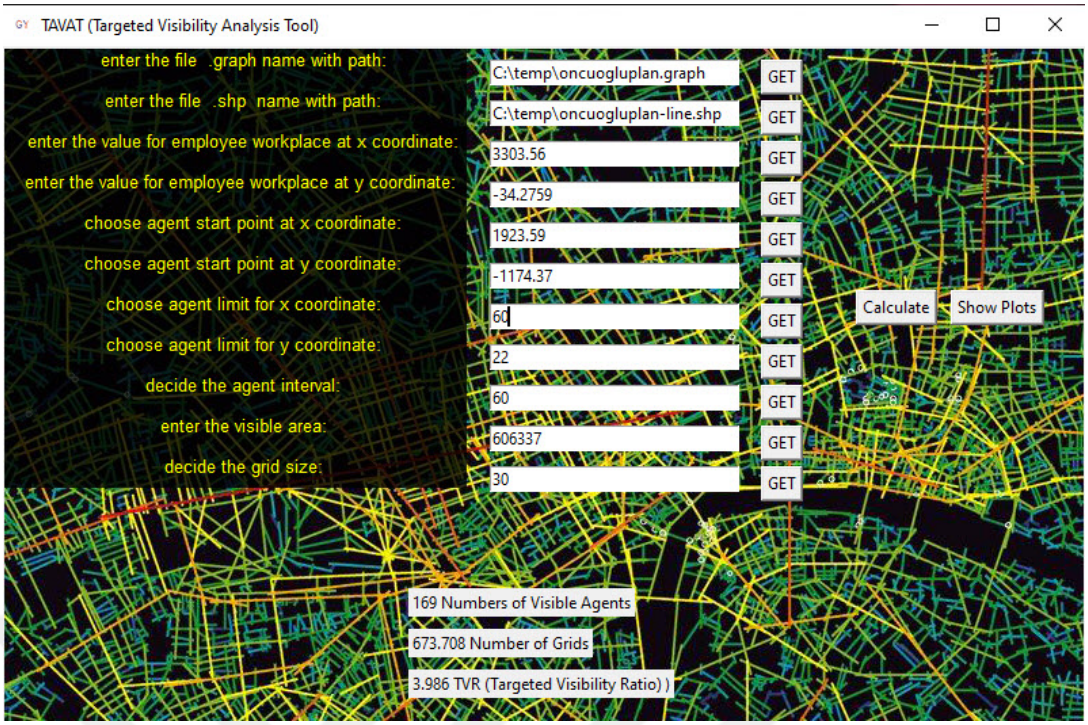

TAVAT (Targeted Visibility Analysis Tool)
enter the file .graph name with path:
enter the file .shp name with path:
enter the value for employee workplace at x coordinate:
enter the value for employee workplace at y coordinate:
choose agent start point at x coordinate:
choose agent start point at y coordinate:
choose agent limit for x coordinate:
choose agent limit for y coordinate:
decide the agent interval:
enter the visible area:
decide the grid size:
C:\temp\oncuogluplan.graph
C:\temp\oncuogluplan-line.shp
3746.47
-344.067
1923.59
-1174.37
14
22
150
537288
30
GET
Calculate
Show Plots
19 Numbers of Visible Agents
596.987 Number of Grids
31.42 TVR (Targeted Visibility Ratio))

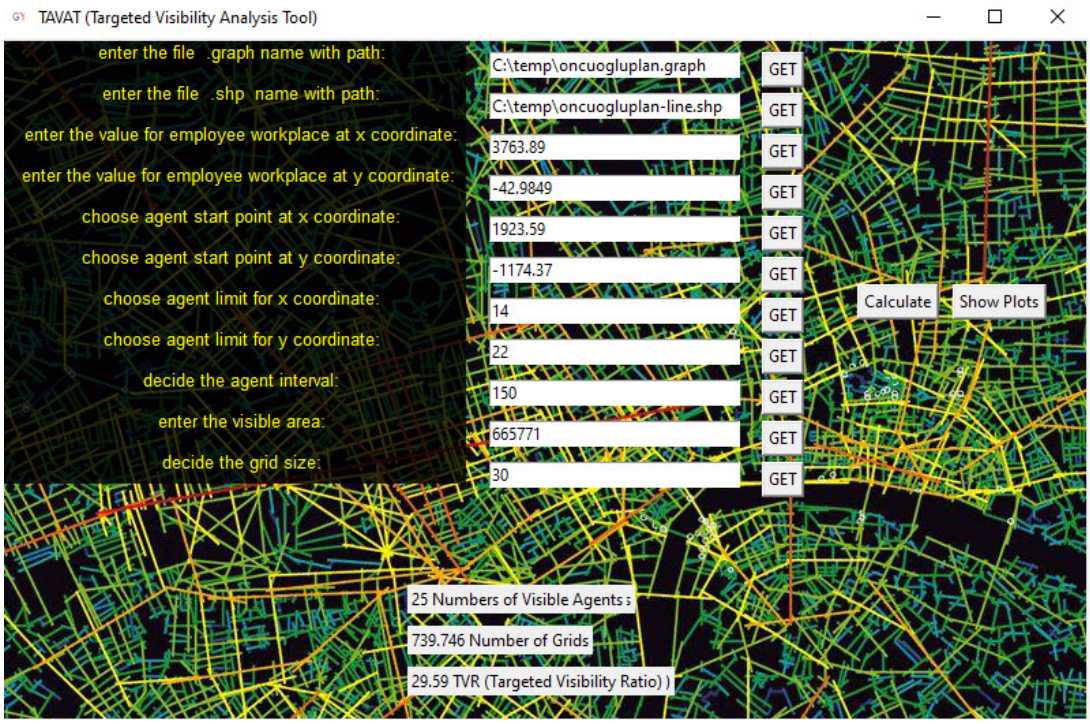

TAVAT (Targeted Visibility Analysis Tool)
enter the file .graph name with path:
enter the file .shp name with path:
enter the value for employee workplace at x coordinate:
enter the value for employee workplace at y coordinate:
choose agent start point at x coordinate:
choose agent start point at y coordinate:
choose agent limit for x coordinate:
choose agent limit for y coordinate:
decide the agent interval:
enter the visible area:
decide the grid size:
C:\temp\oncuogluplan.graph
C:\temp\oncuogluplan-line.shp
3746.47
-344.067
1923.59
-1174.37
60
22
60
537288
30
GET
Calculate
Show Plots
140 Numbers of Visible Agents
596.987 Number of Grids
4.264 TVR (Targeted Visibility Ratio))

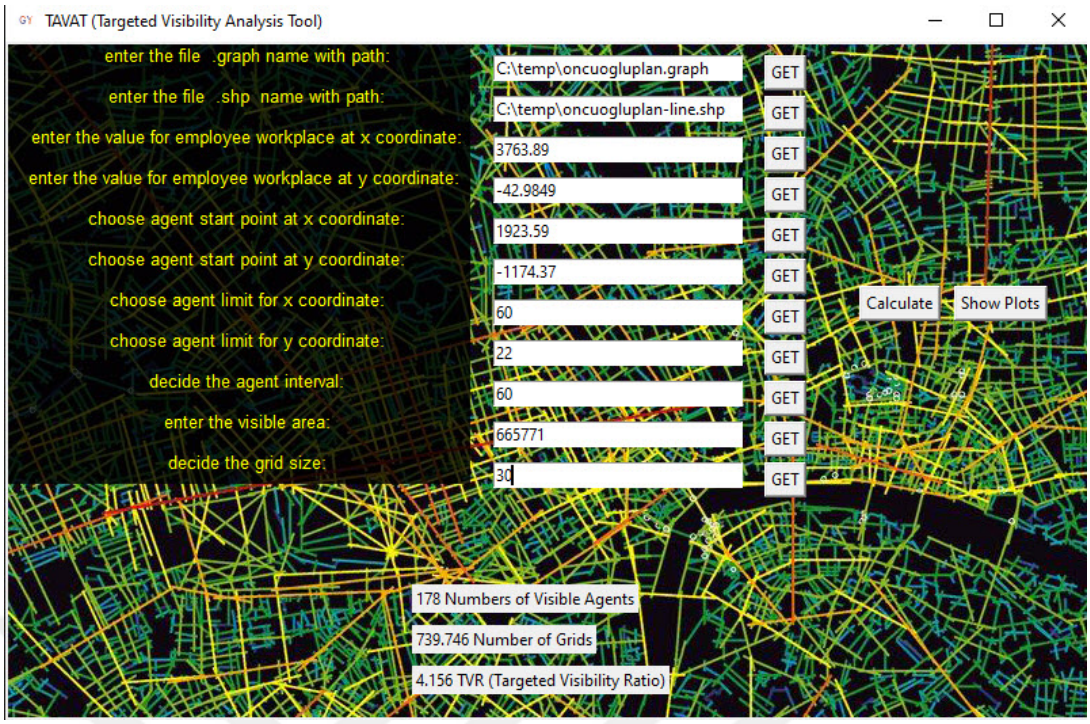

TAVAT (Targeted Visibility Analysis Tool)
enter the file .graph name with path:
enter the file .shp name with path:
enter the value for employee workplace at x coordinate:
enter the value for employee workplace at y coordinate:
choose agent start point at x coordinate:
choose agent start point at y coordinate:
choose agent limit for x coordinate:
choose agent limit for y coordinate:
decide the agent interval:
enter the visible area:
decide the grid size:
C:\temp\oncuogluplan.graph
C:\temp\oncuogluplan-line.shp
3595.93
-325.405
1923.59
-1174.37
14
22
150
161810
30
GET
Calculate
Show Plots
9 Numbers of Visible Agents
179.789 Number of Grids
19.977 TVR (Targeted Visibility Ratio)


TAVAT (Targeted Visibility Analysis Tool)
enter the file .graph name with path:
enter the file .shp name with path:
enter the value for employee workplace at x coordinate:
enter the value for employee workplace at y coordinate:
choose agent start point at x coordinate:
choose agent start point at y coordinate:
choose agent limit for x coordinate:
choose agent limit for y coordinate:
decide the agent interval:
enter the visible area:
decide the grid size:
C:\temp\oncuogluplan.graph
C:\temp\oncuogluplan-line.shp
3595.93
-325.405
1923.59
-1174.37
60
22
60
161810
30
GET
Calculate
Show Plots
50 Numbers of Visible Agents
179.789 Number of Grids
3.596 TVR (Targeted Visibility Ratio))

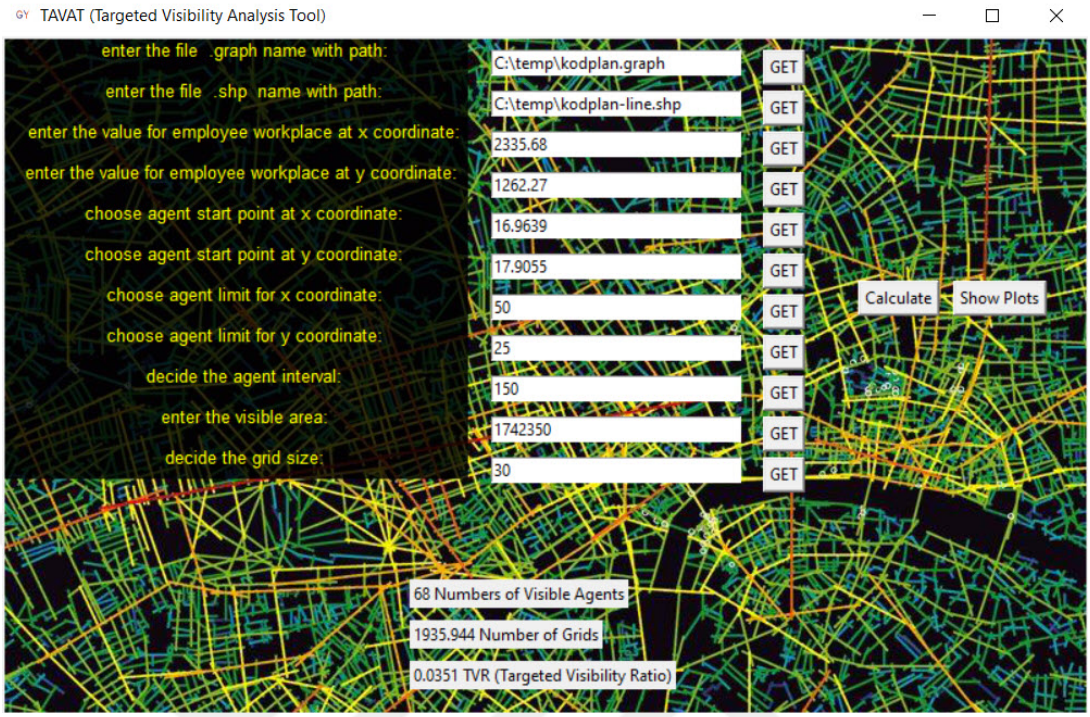

TAVAT (Targeted Visibility Analysis Tool)
enter the file .graph name with path:
enter the file .shp name with path:
enter the value for employee workplace at x coordinate:
enter the value for employee workplace at y coordinate:
choose agent start point at x coordinate:
choose agent start point at y coordinate:
choose agent limit for x coordinate:
choose agent limit for y coordinate:
decide the agent interval:
enter the visible area:
decide the grid size:
C:\temp\oncuogluplan.graph
C:\temp\oncuogluplan-line.shp
3303.56
-34.2759
1923.59
-1174.37
14
22
150
606337
30
GET
Calculate
Show Plots
25 Numbers of Visible Agents
673.708 Number of Grids
26.948 TVR (Targeted Visibility Ratio)

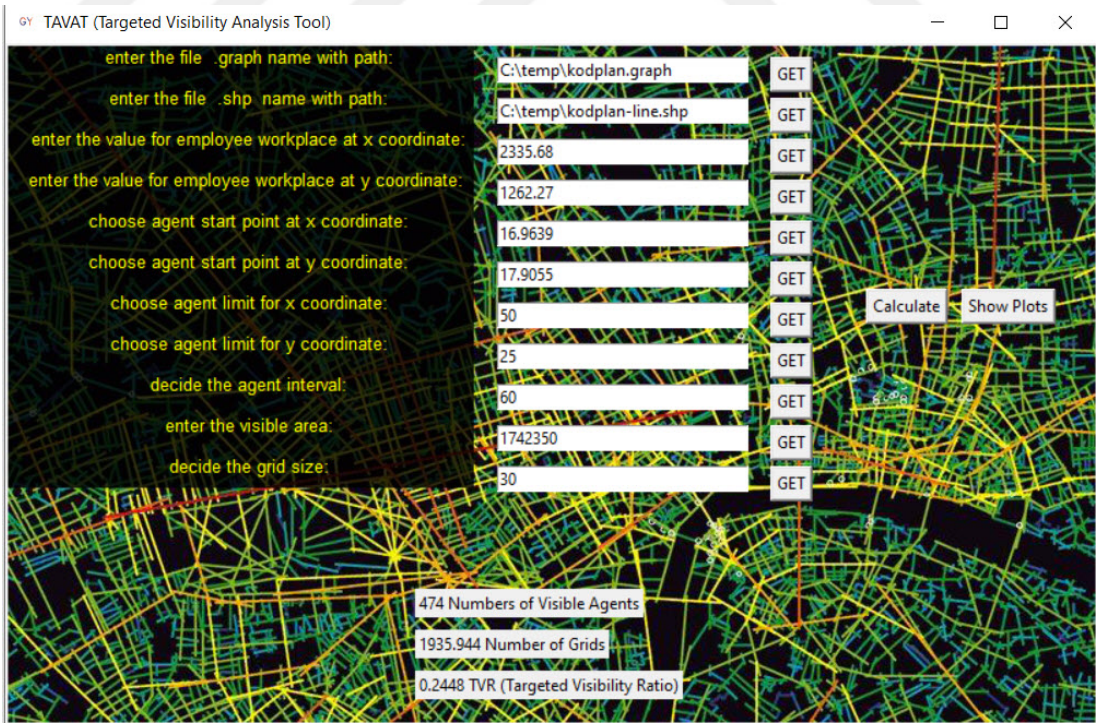

TAVAT (Targeted Visibility Analysis Tool)
enter the file .graph name with path:
enter the file .shp name with path:
enter the value for employee workplace at x coordinate:
enter the value for employee workplace at y coordinate:
choose agent start point at x coordinate:
choose agent start point at y coordinate:
choose agent limit for x coordinate:
choose agent limit for y coordinate:
decide the agent interval:
enter the visible area:
decide the grid size:
C:\temp\oncuogluplan.graph
C:\temp\oncuogluplan-line.shp
3303.56
-34.2759
1923.59
-1174.37
60
22
60
606337
30
GET
Calculate
Show Plots
169 Numbers of Visible Agents
673.708 Number of Grids
3.986 TVR (Targeted Visibility Ratio))

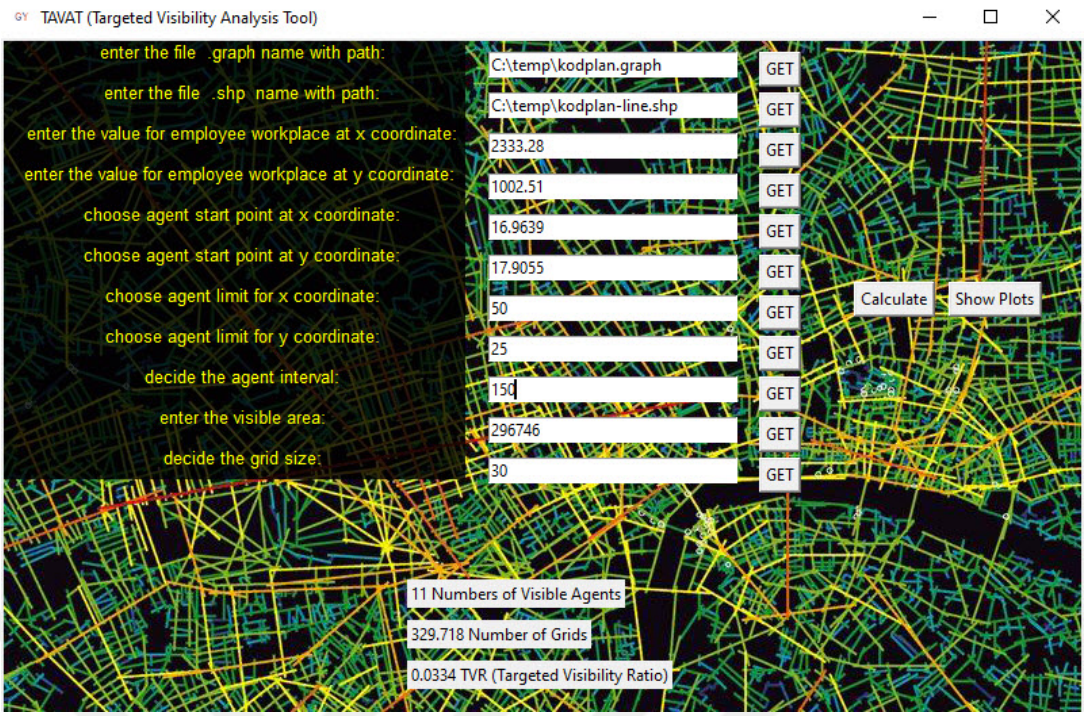

TAVAT (Targeted Visibility Analysis Tool)
enter the file .graph name with path:
enter the file .shp name with path:
enter the value for employee workplace at x coordinate:
enter the value for employee workplace at y coordinate:
choose agent start point at x coordinate:
choose agent start point at y coordinate:
choose agent limit for x coordinate:
choose agent limit for y coordinate:
decide the agent interval:
enter the visible area:
decide the grid size:
C:\temp\oncuogluplan.graph
C:\temp\oncuogluplan-line.shp
3763.89
-42.9849
1923.59
-1174.37
14
22
150
665771
30
GET
Calculate
Show Plots
25 Numbers of Visible Agents
739.746 Number of Grids
29.59 TVR (Targeted Visibility Ratio))

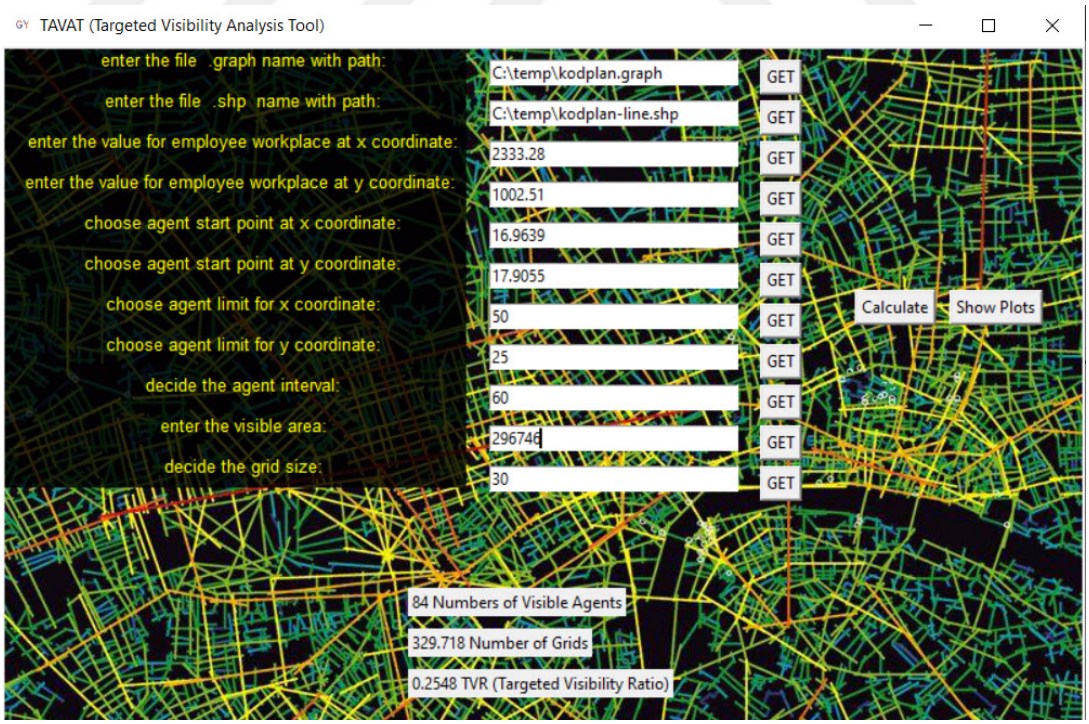

TAVAT (Targeted Visibility Analysis Tool)
enter the file .graph name with path:
enter the file .shp name with path:
enter the value for employee workplace at x coordinate:
enter the value for employee workplace at y coordinate:
choose agent start point at x coordinate:
choose agent start point at y coordinate:
choose agent limit for x coordinate:
choose agent limit for y coordinate:
decide the agent interval:
enter the visible area:
decide the grid size:
C:\temp\oncuogluplan.graph
C:\temp\oncuogluplan-line.shp
3763.89
-42.9849
1923.59
-1174.37
60
22
60
665771
30
GET
Calculate
Show Plots
178 Numbers of Visible Agents
739.746 Number of Grids
4.156 TVR (Targeted Visibility Ratio)

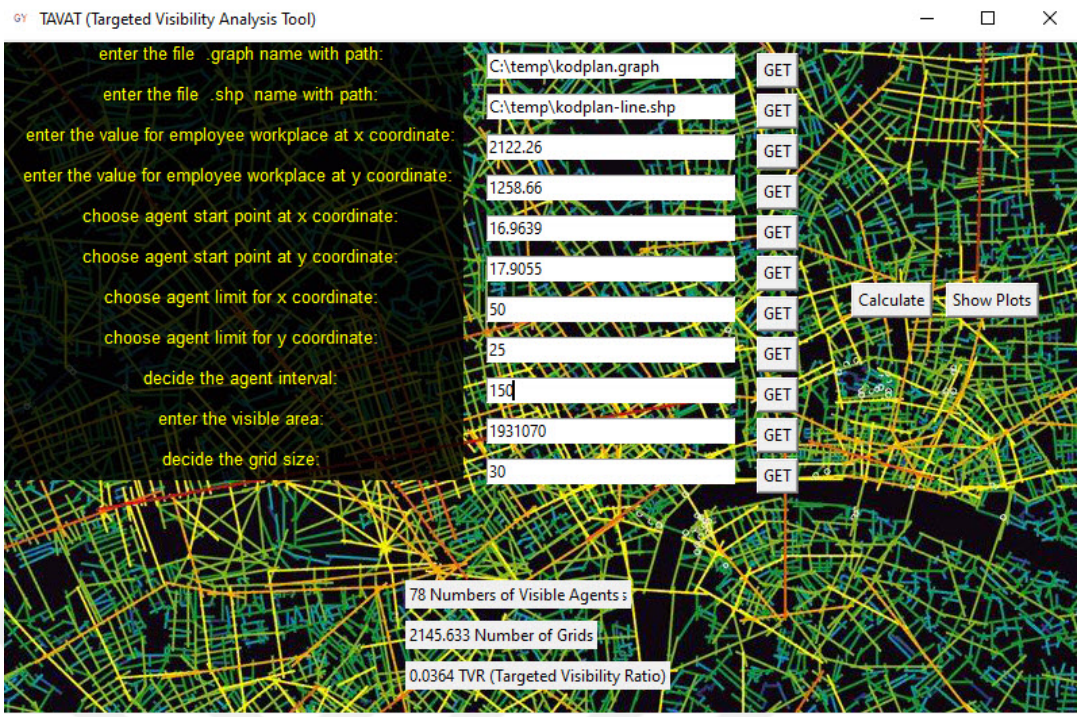
APPENDIX G. Targeted Visibility Ratio Outputs for Tepe Home

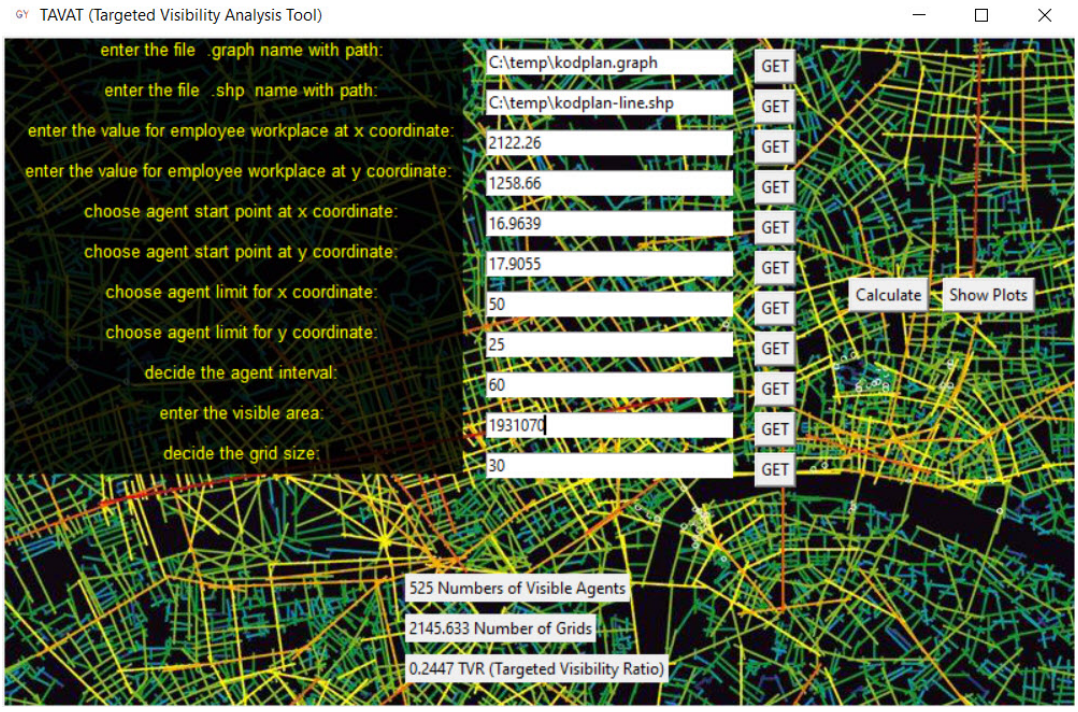


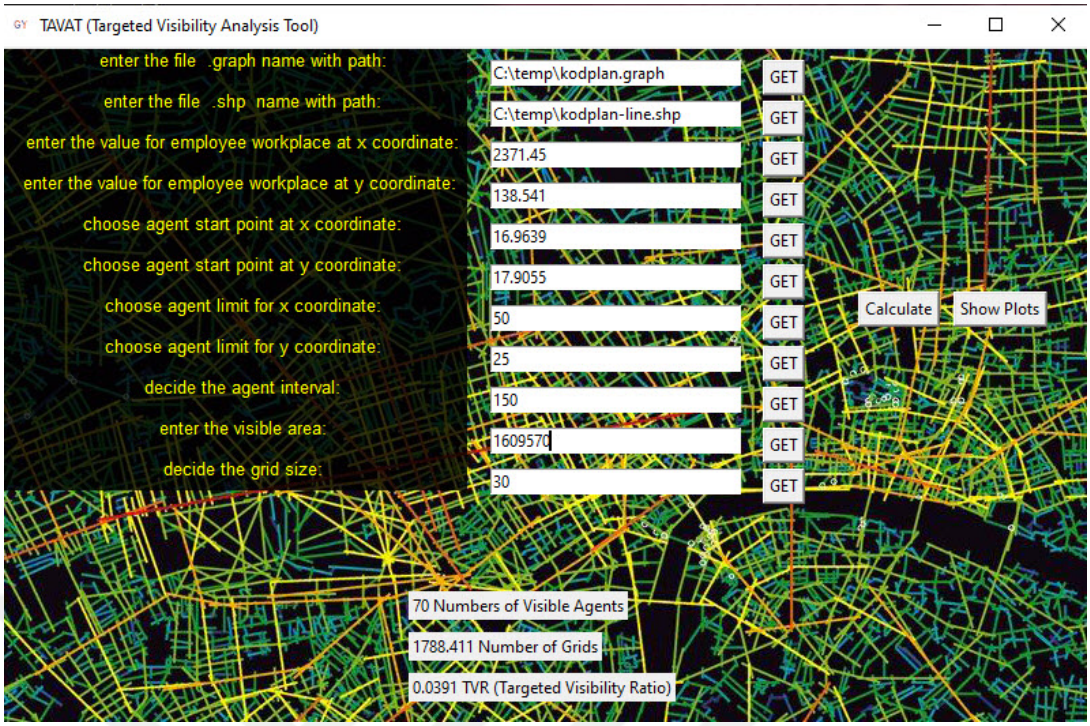


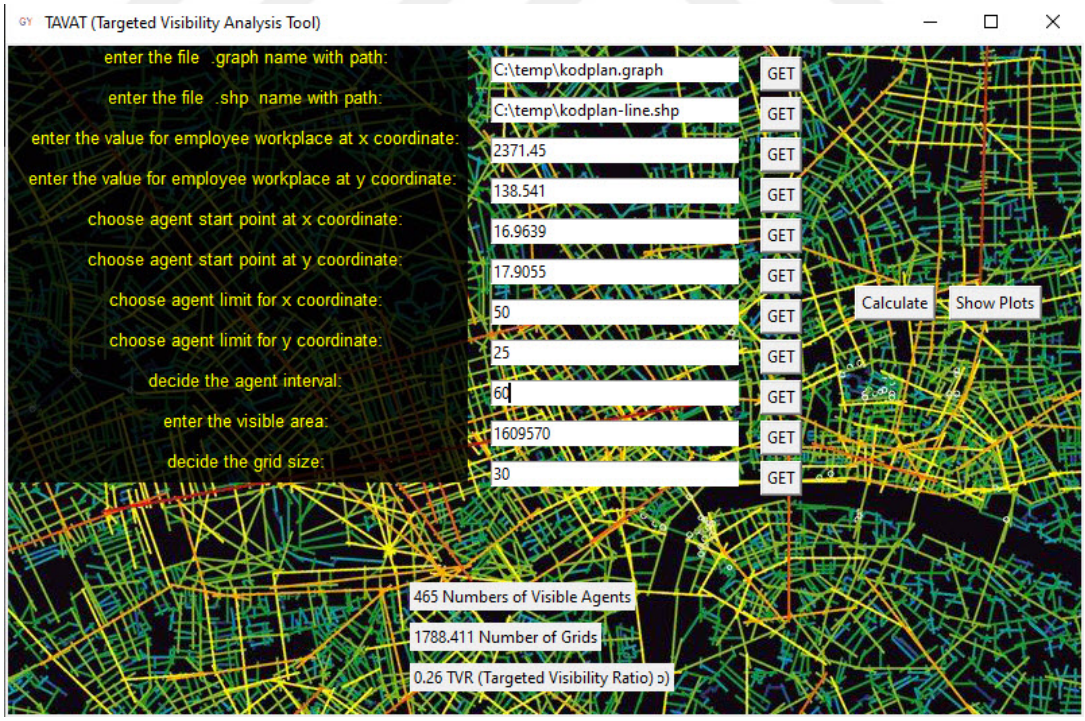

TAVAT (Targeted Visibility Analysis Tool)
enter the file .graph name with path:
enter the file .shp name with path:
enter the value for employee workplace at x coordinate:
enter the value for employee workplace at y coordinate:
choose agent start point at x coordinate:
choose agent start point at y coordinate:
choose agent limit for x coordinate:
choose agent limit for y coordinate:
decide the agent interval:
enter the visible area:
decide the grid size:
C:\temp\kodplan.graph
C:\temp\kodplan-line.shp
2333.28
1002.51
16.9639
17.9055
50
25
150
296746
30
GET
Calculate
Show Plots
11 Numbers of Visible Agents
329.718 Number of Grids
0.0334 TVR (Targeted Visibility Ratio)

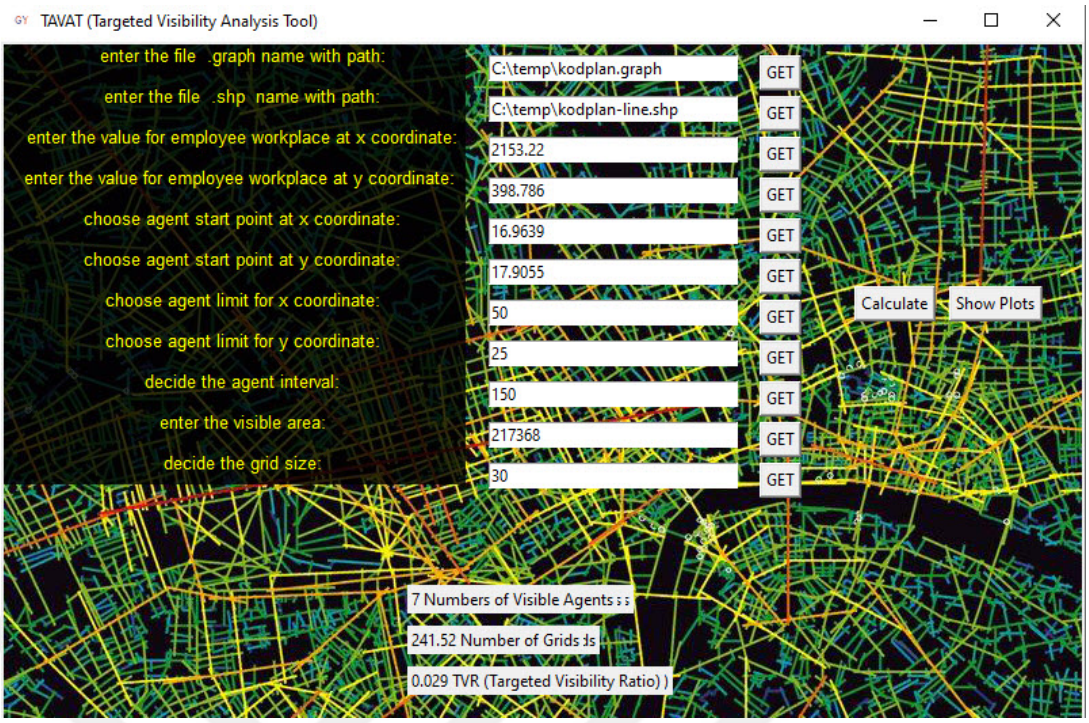

TAVAT (Targeted Visibility Analysis Tool)
enter the file .graph name with path:
enter the file .shp name with path:
enter the value for employee workplace at x coordinate:
enter the value for employee workplace at y coordinate:
choose agent start point at x coordinate:
choose agent start point at y coordinate:
choose agent limit for x coordinate:
choose agent limit for y coordinate:
decide the agent interval:
enter the visible area:
decide the grid size:
C:\temp\kodplan.graph
C:\temp\kodplan-line.shp
2333.28
1002.51
16.9639
17.9055
50
25
60
296746
30
GET
Calculate
Show Plots
84 Numbers of Visible Agents
329.718 Number of Grids
0.2548 TVR (Targeted Visibility Ratio)

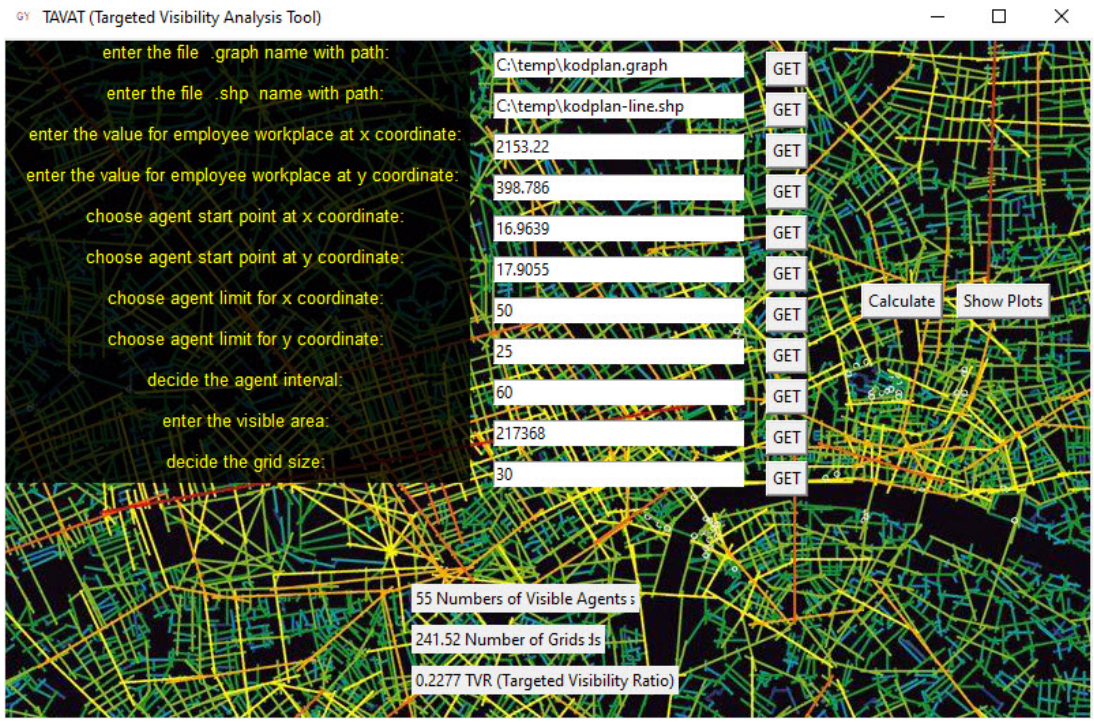

TAVAT (Targeted Visibility Analysis Tool)
enter the file .graph name with path:
enter the file .shp name with path:
enter the value for employee workplace at x coordinate:
enter the value for employee workplace at y coordinate:
choose agent start point at x coordinate:
choose agent start point at y coordinate:
choose agent limit for x coordinate:
choose agent limit for y coordinate:
decide the agent interval:
enter the visible area:
decide the grid size:
C:\temp\kodplan.graph
C:\temp\kodplan-line.shp
2122.26
1258.66
16.9639
17.9055
50
25
150
1931070
30
GET
Calculate
Show Plots
78 Numbers of Visible Agents
2145.633 Number of Grids
0.0364 TVR (Targeted Visibility Ratio)

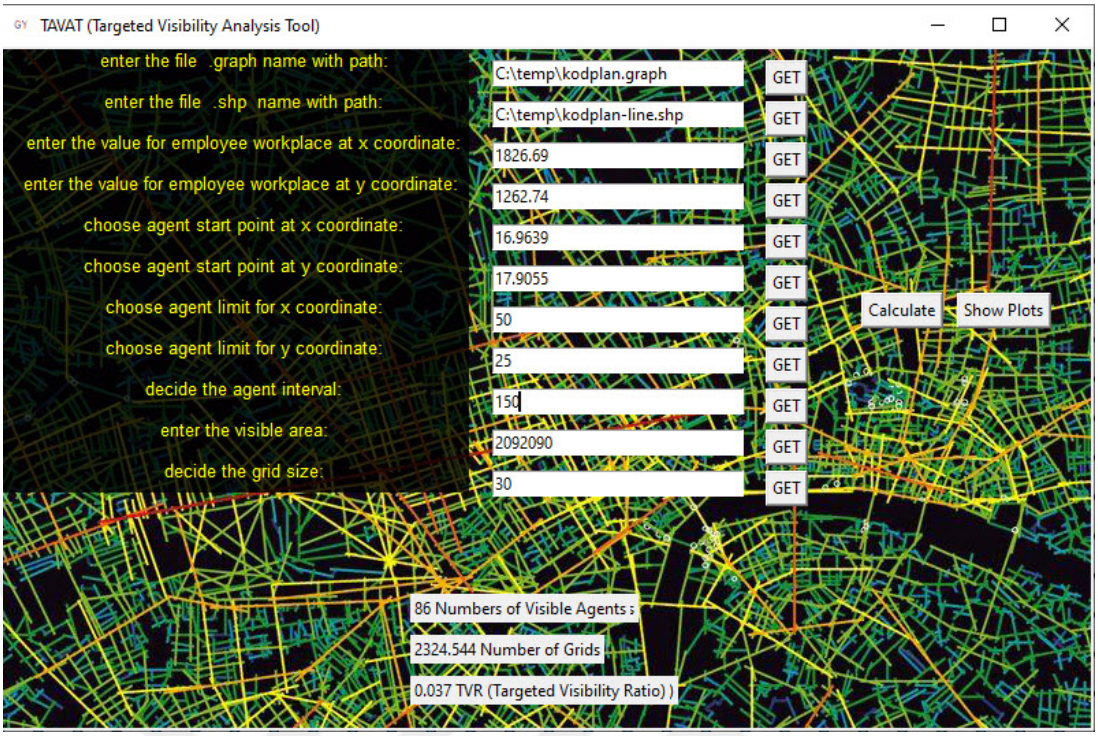

TAVAT (Targeted Visibility Analysis Tool)
enter the file .graph name with path:
enter the file .shp name with path:
enter the value for employee workplace at x coordinate:
enter the value for employee workplace at y coordinate:
choose agent start point at x coordinate:
choose agent start point at y coordinate:
choose agent limit for x coordinate:
choose agent limit for y coordinate:
decide the agent interval:
enter the visible area:
decide the grid size:
C:\temp\kodplan.graph
C:\temp\kodplan-line.shp
2122.26
1258.66
16.9639
17.9055
50
25
60
1931070
30
GET
Calculate
Show Plots
525 Numbers of Visible Agents
2145.633 Number of Grids
0.2447 TVR (Targeted Visibility Ratio)

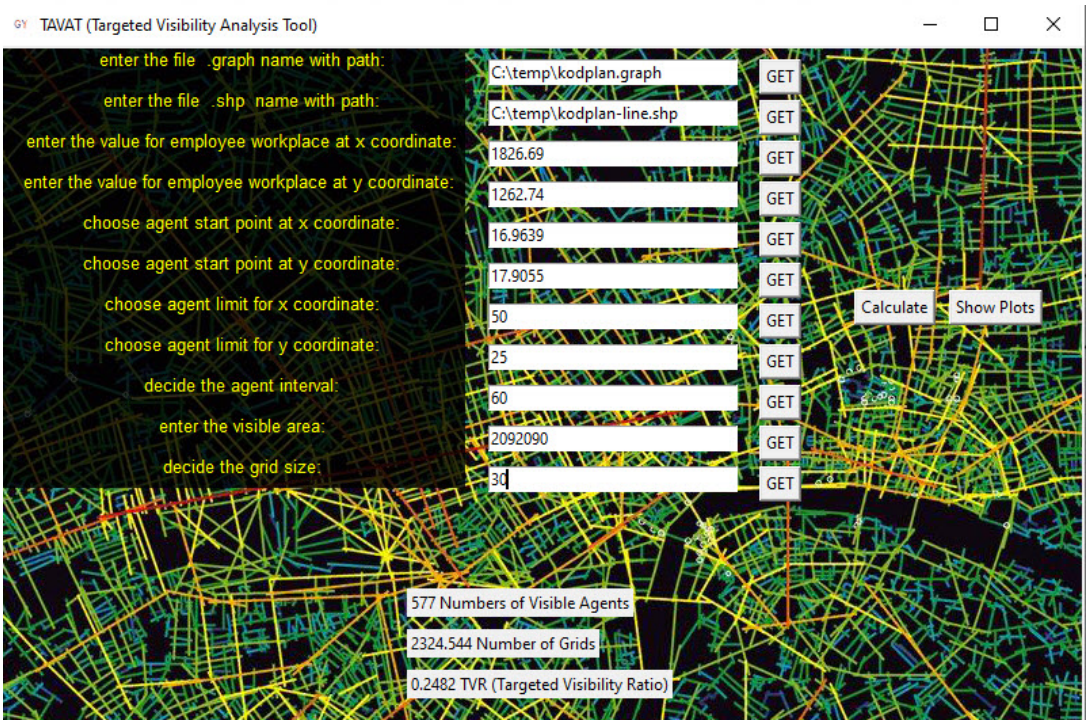

TAVAT (Targeted Visibility Analysis Tool)
enter the file .graph name with path:
enter the file .shp name with path:
enter the value for employee workplace at x coordinate:
enter the value for employee workplace at y coordinate:
choose agent start point at x coordinate:
choose agent start point at y coordinate:
choose agent limit for x coordinate:
choose agent limit for y coordinate:
decide the agent interval:
enter the visible area:
decide the grid size:
C:\temp\kodplan.graph
C:\temp\kodplan-line.shp
2371.45
138.541
16.9639
17.9055
50
25
150
1609570
30
GET
Calculate
Show Plots
70 Numbers of Visible Agents
1788.411 Number of Grids
0.0391 TVR (Targeted Visibility Ratio)

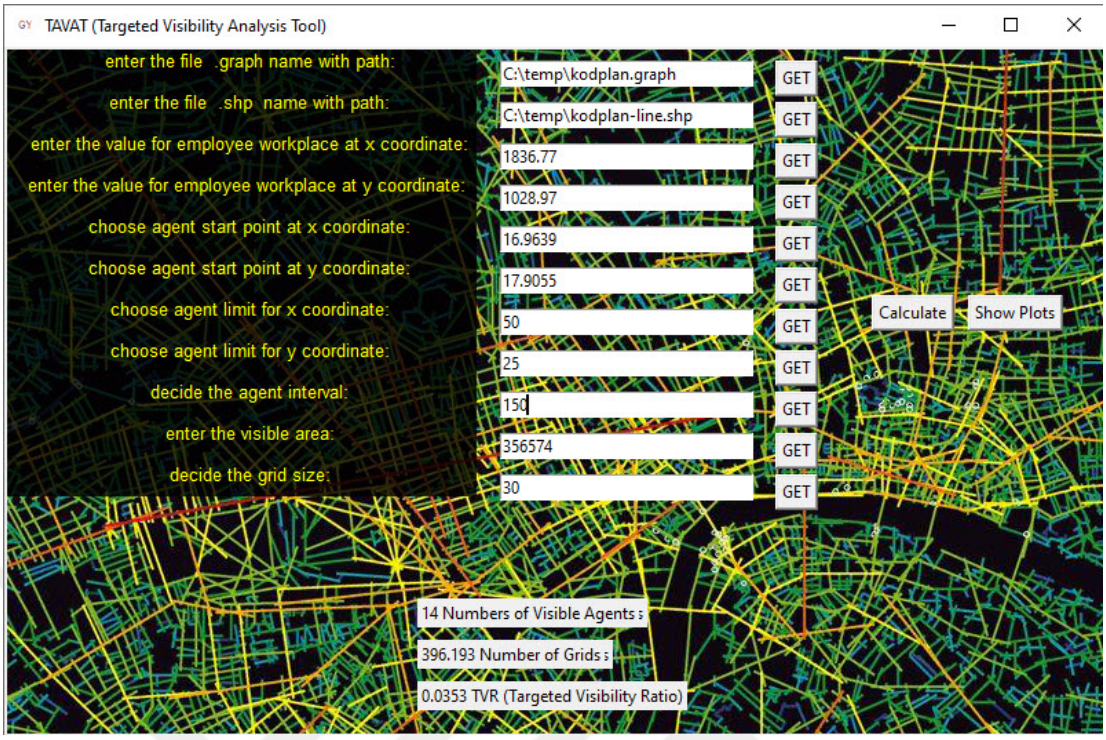

TAVAT (Targeted Visibility Analysis Tool)
enter the file .graph name with path:
enter the file .shp name with path:
enter the value for employee workplace at x coordinate:
enter the value for employee workplace at y coordinate:
choose agent start point at x coordinate:
choose agent start point at y coordinate:
choose agent limit for x coordinate:
choose agent limit for y coordinate:
decide the agent interval:
enter the visible area:
decide the grid size:
C:\temp\kodplan.graph
C:\temp\kodplan-line.shp
2371.45
138.541
16.9639
17.9055
50
25
60
1609570
30
GET
Calculate
Show Plots
465 Numbers of Visible Agents
1788.411 Number of Grids
0.26 TVR (Targeted Visibility Ratio)

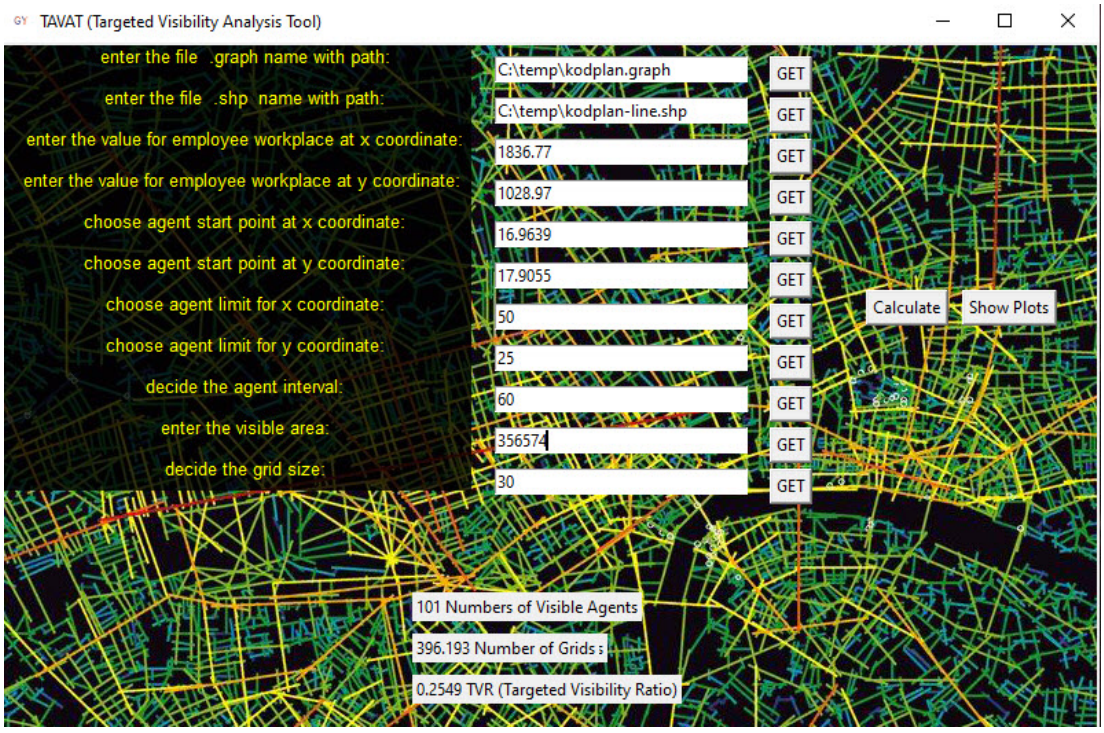

TAVAT (Targeted Visibility Analysis Tool)
enter the file .graph name with path:
enter the file .shp name with path:
enter the value for employee workplace at x coordinate:
enter the value for employee workplace at y coordinate:
choose agent start point at x coordinate:
choose agent start point at y coordinate:
choose agent limit for x coordinate:
choose agent limit for y coordinate:
decide the agent interval:
enter the visible area:
decide the grid size:
C:\temp\kodplan.graph
C:\temp\kodplan-line.shp
2153.22
398.786
16.9639
17.9055
50
25
150
217368
30
GET
Calculate
Show Plots
7 Numbers of Visible Agents : :
241.52 Number of Grids is
0.029 TVR (Targeted Visibility Ratio))

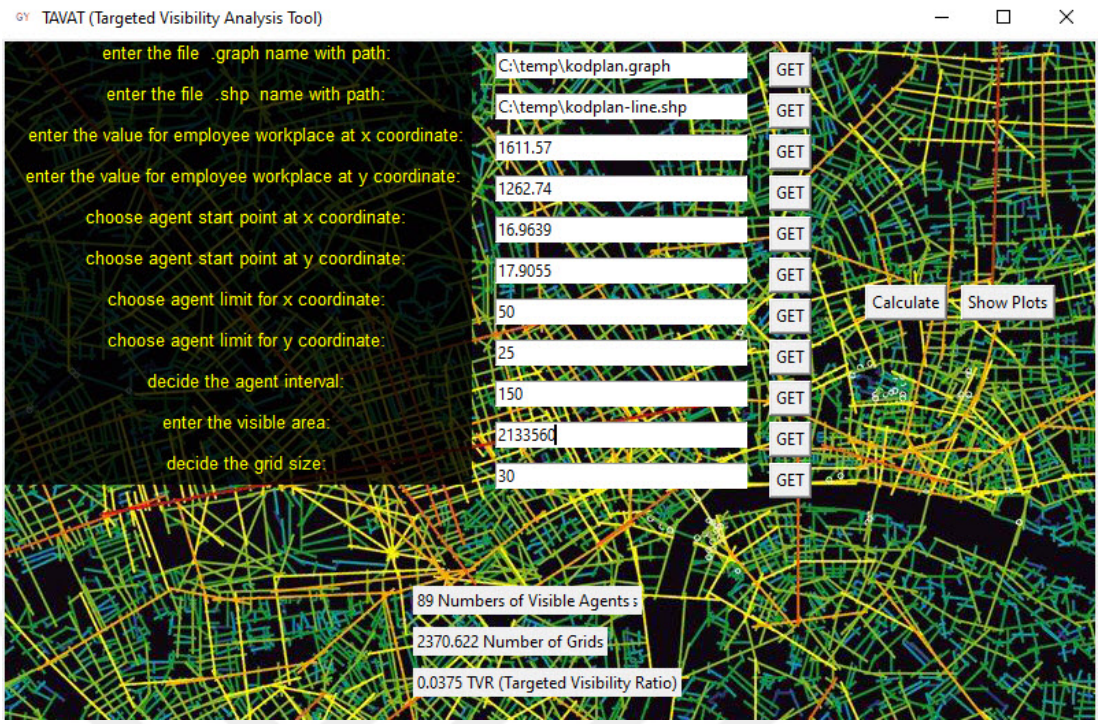

TAVAT (Targeted Visibility Analysis Tool)
enter the file .graph name with path:
enter the file .shp name with path:
enter the value for employee workplace at x coordinate:
enter the value for employee workplace at y coordinate:
choose agent start point at x coordinate:
choose agent start point at y coordinate:
choose agent limit for x coordinate:
choose agent limit for y coordinate:
decide the agent interval:
enter the visible area:
decide the grid size:
C:\temp\kodplan.graph
C:\temp\kodplan-line.shp
2153.22
398.786
16.9639
17.9055
50
25
60
217368
30
GET
Calculate
Show Plots
55 Numbers of Visible Agents :
241.52 Number of Grids is
0.2277 TVR (Targeted Visibility Ratio)

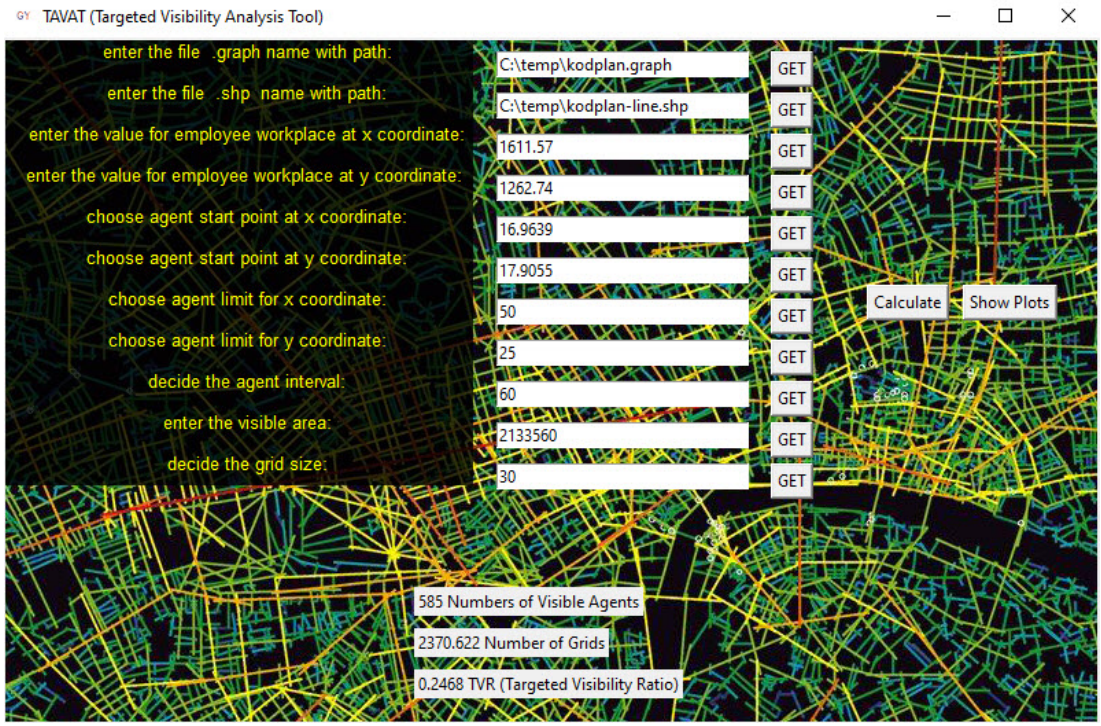

TAVAT (Targeted Visibility Analysis Tool)
enter the file .graph name with path:
enter the file .shp name with path:
enter the value for employee workplace at x coordinate:
enter the value for employee workplace at y coordinate:
choose agent start point at x coordinate:
choose agent start point at y coordinate:
choose agent limit for x coordinate:
choose agent limit for y coordinate:
decide the agent interval:
enter the visible area:
decide the grid size:
C:\temp\kodplan.graph
C:\temp\kodplan-line.shp
1826.69
1262.74
16.9639
17.9055
50
25
150
2092090
30
GET
Calculate
Show Plots
86 Numbers of Visible Agents
2324.544 Number of Grids
0.037 TVR (Targeted Visibility Ratio))

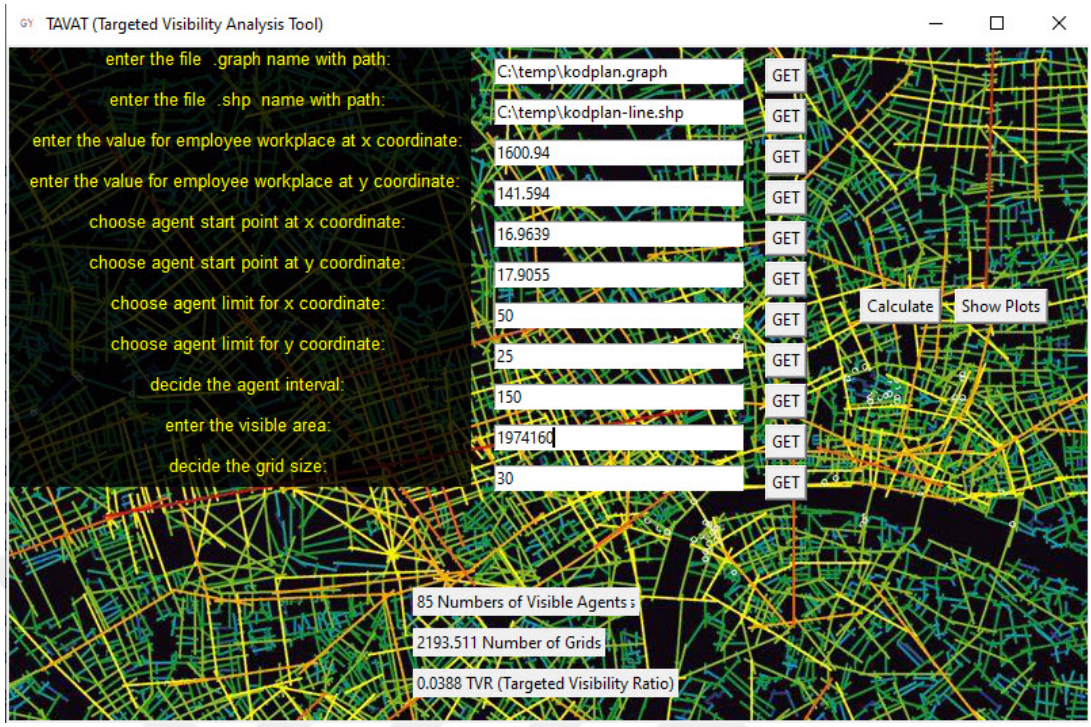

TAVAT (Targeted Visibility Analysis Tool)
enter the file .graph name with path:
enter the file .shp name with path:
enter the value for employee workplace at x coordinate:
enter the value for employee workplace at y coordinate:
choose agent start point at x coordinate:
choose agent start point at y coordinate:
choose agent limit for x coordinate:
choose agent limit for y coordinate:
decide the agent interval:
enter the visible area:
decide the grid size:
C:\temp\kodplan.graph
C:\temp\kodplan-line.shp
1826.69
1262.74
16.9639
17.9055
50
25
60
2092090
30
GET
Calculate
Show Plots
577 Numbers of Visible Agents
2324.544 Number of Grids
0.2482 TVR (Targeted Visibility Ratio)

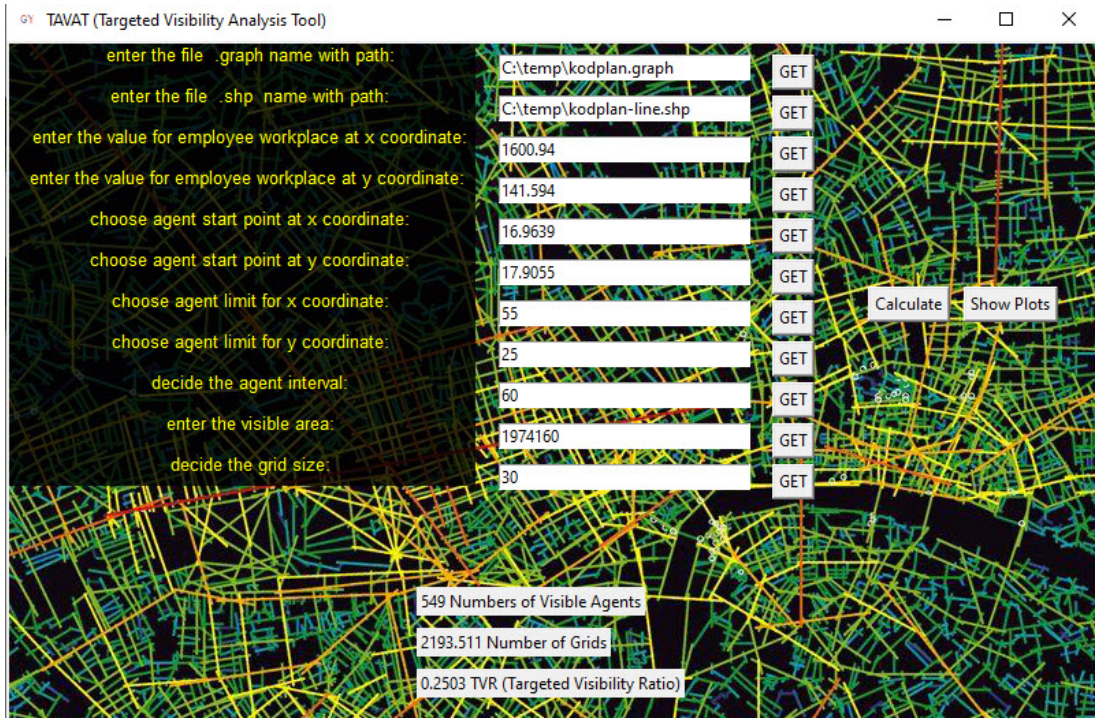

TAVAT (Targeted Visibility Analysis Tool)
enter the file .graph name with path:
enter the file .shp name with path:
enter the value for employee workplace at x coordinate:
enter the value for employee workplace at y coordinate:
choose agent start point at x coordinate:
choose agent start point at y coordinate:
choose agent limit for x coordinate:
choose agent limit for y coordinate:
decide the agent interval:
enter the visible area:
decide the grid size:
C:\temp\kodplan.graph
C:\temp\kodplan-line.shp
1836.77
1028.97
16.9639
17.9055
50
25
150
356574
30
GET
Calculate
Show Plots
14 Numbers of Visible Agents
396.193 Number of Grids
0.0353 TVR (Targeted Visibility Ratio)

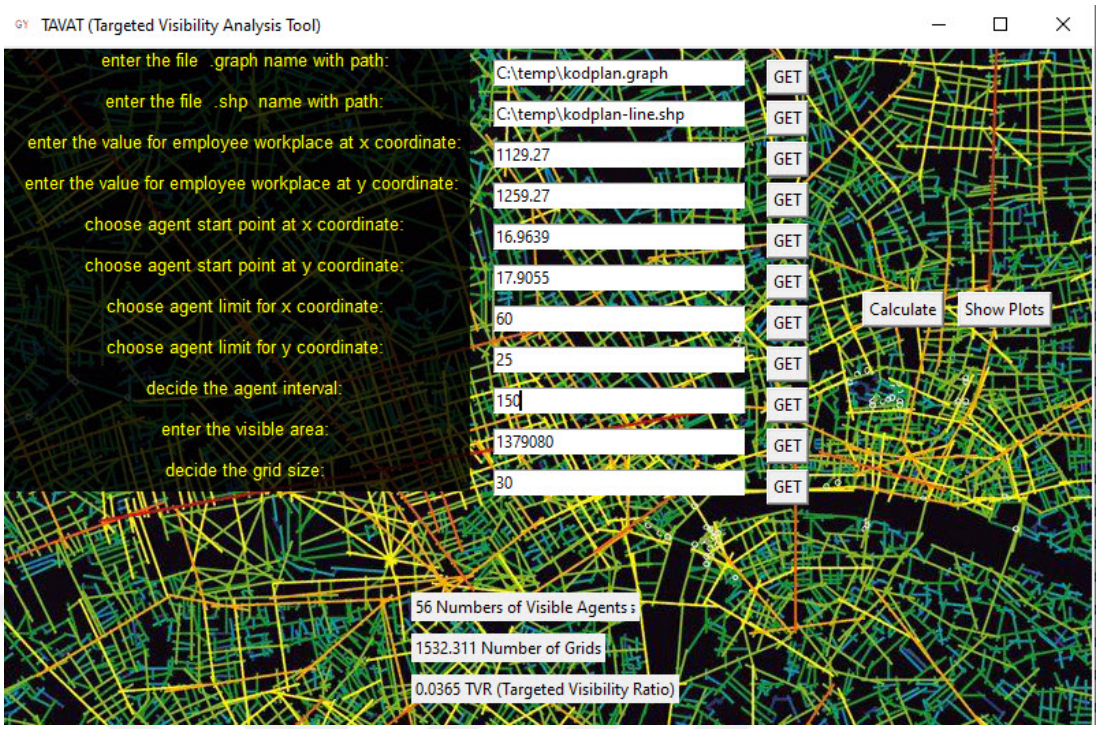

TAVAT (Targeted Visibility Analysis Tool)
enter the file .graph name with path:
enter the file .shp name with path:
enter the value for employee workplace at x coordinate:
enter the value for employee workplace at y coordinate:
choose agent start point at x coordinate:
choose agent start point at y coordinate:
choose agent limit for x coordinate:
choose agent limit for y coordinate:
decide the agent interval:
enter the visible area:
decide the grid size:
C:\temp\kodplan.graph
C:\temp\kodplan-line.shp
1836.77
1028.97
16.9639
17.9055
50
25
60
356574
30
GET
Calculate
Show Plots
101 Numbers of Visible Agents
396.193 Number of Grids
0.2549 TVR (Targeted Visibility Ratio)

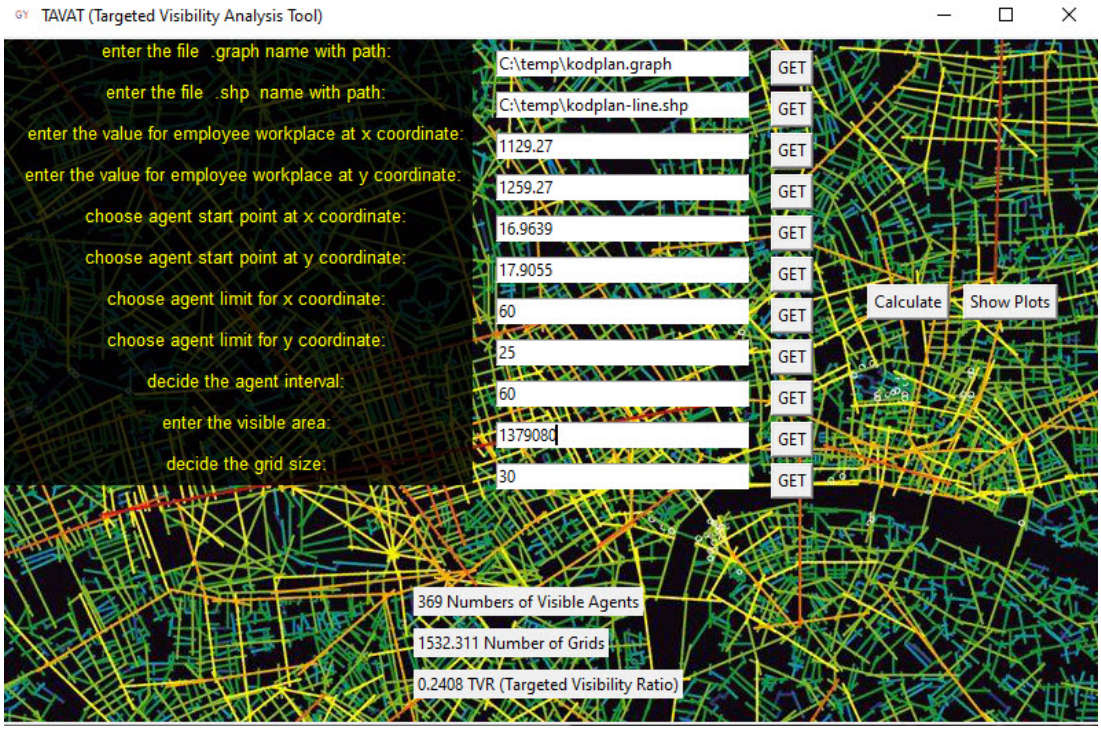

TAVAT (Targeted Visibility Analysis Tool)
enter the file .graph name with path:
enter the file .shp name with path:
enter the value for employee workplace at x coordinate:
enter the value for employee workplace at y coordinate:
choose agent start point at x coordinate:
choose agent start point at y coordinate:
choose agent limit for x coordinate:
choose agent limit for y coordinate:
decide the agent interval:
enter the visible area:
decide the grid size:
C:\temp\kodplan.graph
C:\temp\kodplan-line.shp
1611.57
1262.74
16.9639
17.9055
50
25
150
2133560
30
GET
Calculate
Show Plots
89 Numbers of Visible Agents
2370.622 Number of Grids
0.0375 TVR (Targeted Visibility Ratio)

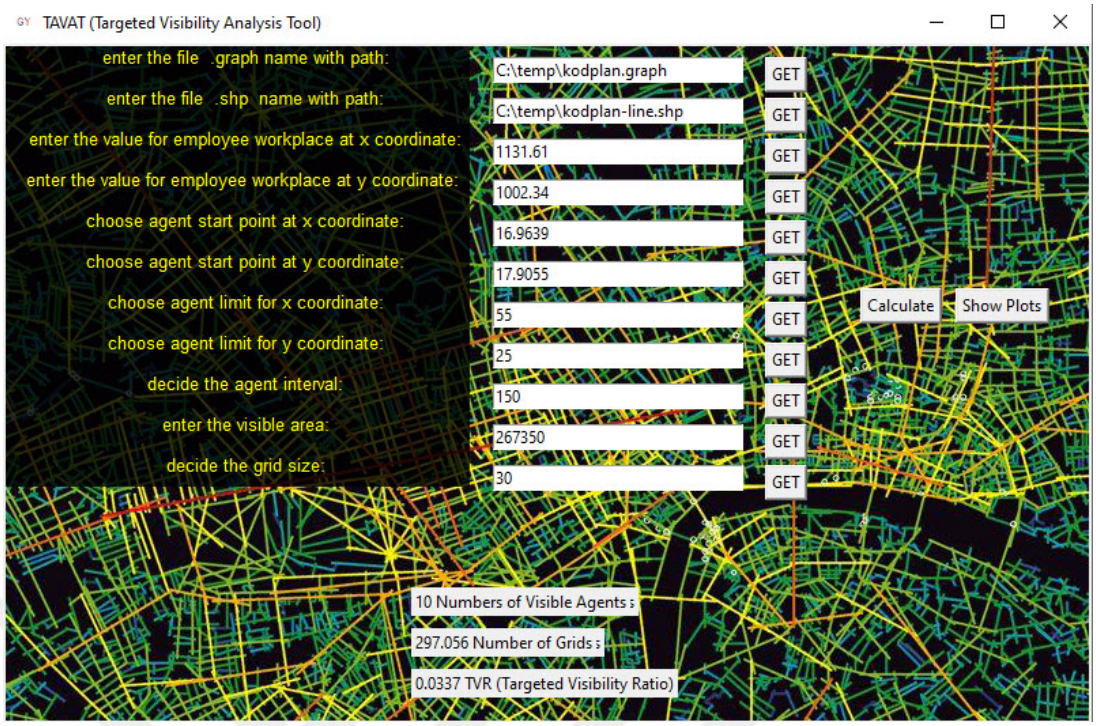

TAVAT (Targeted Visibility Analysis Tool)
enter the file .graph name with path:
enter the file .shp name with path:
enter the value for employee workplace at x coordinate:
enter the value for employee workplace at y coordinate:
choose agent start point at x coordinate:
choose agent start point at y coordinate:
choose agent limit for x coordinate:
choose agent limit for y coordinate:
decide the agent interval:
enter the visible area:
decide the grid size:
C:\temp\kodplan.graph
C:\temp\kodplan-line.shp
1611.57
1262.74
16.9639
17.9055
50
25
60
2133560
30
GET
Calculate
Show Plots
585 Numbers of Visible Agents
2370.622 Number of Grids
0.2468 TVR (Targeted Visibility Ratio)

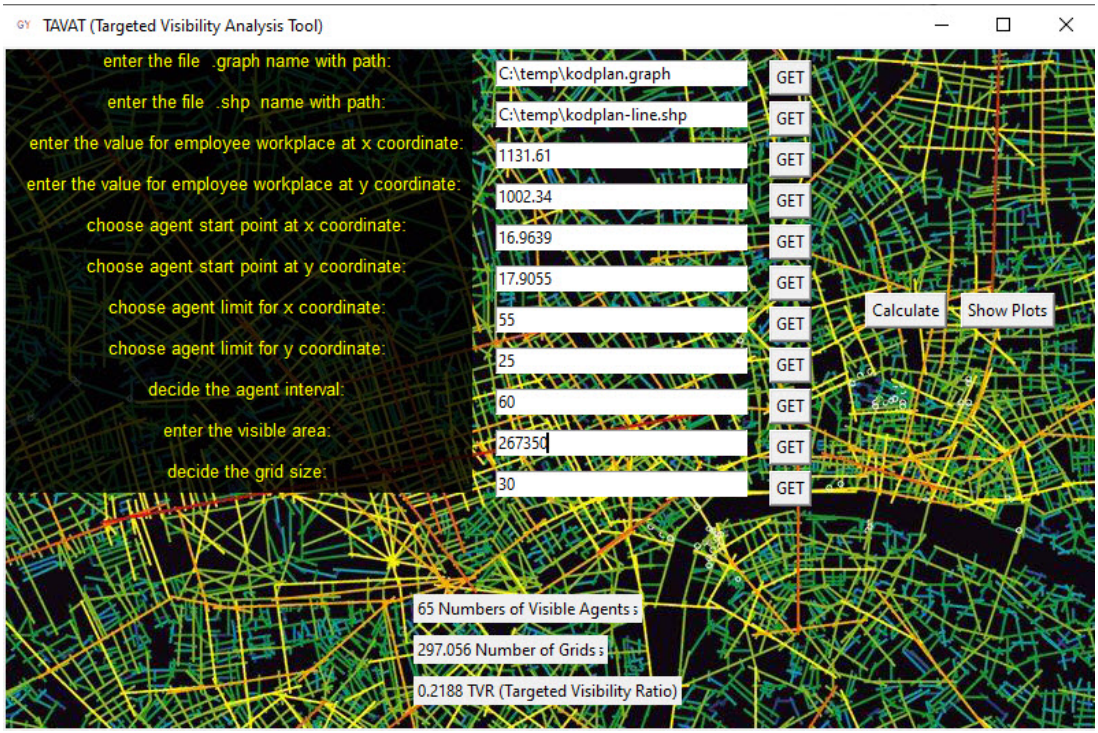

TAVAT (Targeted Visibility Analysis Tool)
enter the file .graph name with path:
enter the file .shp name with path:
enter the value for employee workplace at x coordinate:
enter the value for employee workplace at y coordinate:
choose agent start point at x coordinate:
choose agent start point at y coordinate:
choose agent limit for x coordinate:
choose agent limit for y coordinate:
decide the agent interval:
enter the visible area:
decide the grid size:
C:\temp\kodplan.graph
C:\temp\kodplan-line.shp
1600.94
141.594
16.9639
17.9055
50
25
150
1974160
30
GET
Calculate
Show Plots
85 Numbers of Visible Agents
2193.511 Number of Grids
0.0388 TVR (Targeted Visibility Ratio)

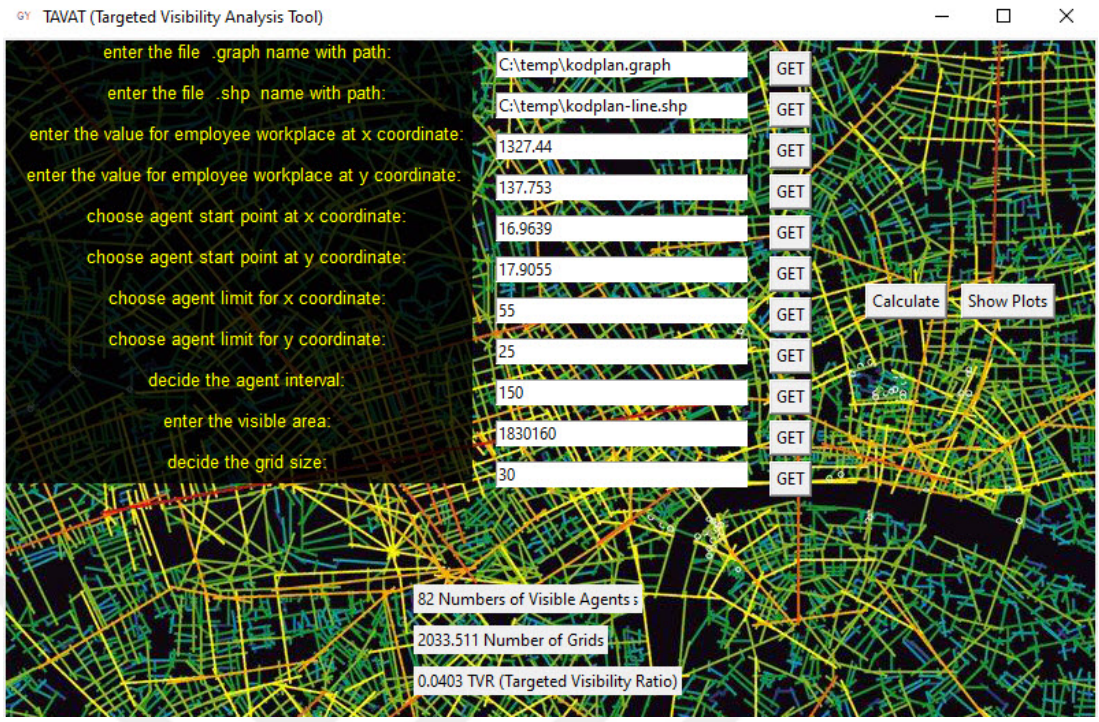

TAVAT (Targeted Visibility Analysis Tool)
enter the file .graph name with path:
enter the file .shp name with path:
enter the value for employee workplace at x coordinate:
enter the value for employee workplace at y coordinate:
choose agent start point at x coordinate:
choose agent start point at y coordinate:
choose agent limit for x coordinate:
choose agent limit for y coordinate:
decide the agent interval:
enter the visible area:
decide the grid size:
C:\temp\kodplan.graph
C:\temp\kodplan-line.shp
1600.94
141.594
16.9639
17.9055
55
25
60
1974160
30
GET
Calculate
Show Plots
549 Numbers of Visible Agents
2193.511 Number of Grids
0.2503 TVR (Targeted Visibility Ratio)

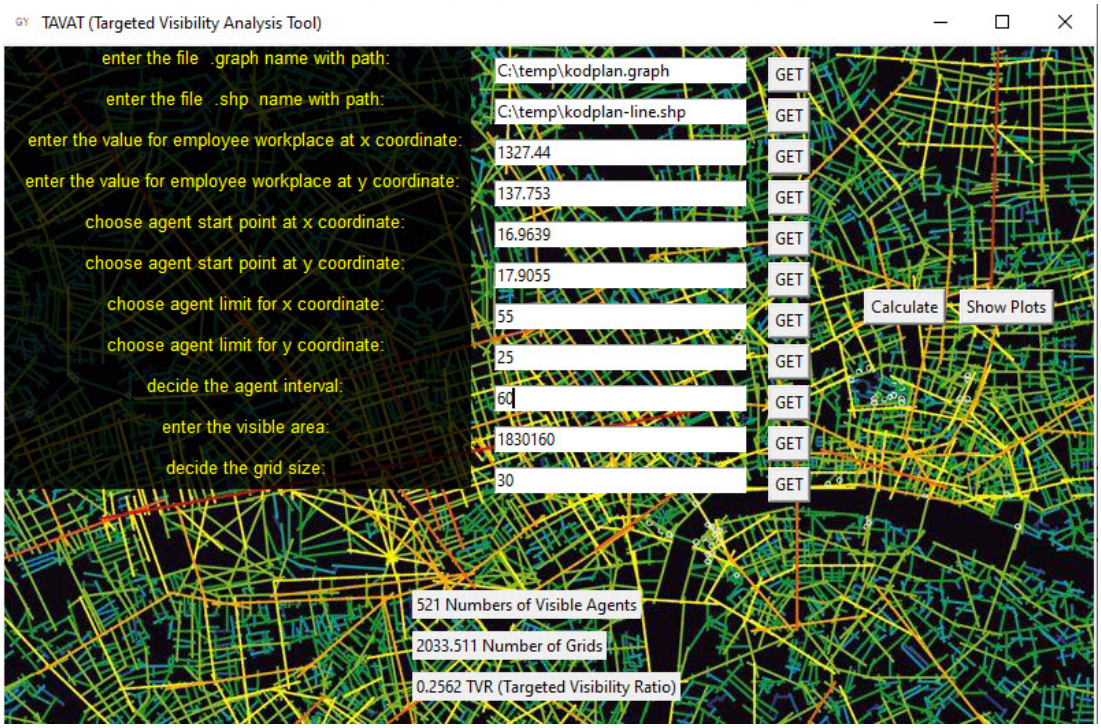

TAVAT (Targeted Visibility Analysis Tool)
enter the file .graph name with path:
enter the file .shp name with path:
enter the value for employee workplace at x coordinate:
enter the value for employee workplace at y coordinate:
choose agent start point at x coordinate:
choose agent start point at y coordinate:
choose agent limit for x coordinate:
choose agent limit for y coordinate:
decide the agent interval:
enter the visible area:
decide the grid size:
C:\temp\kodplan.graph
C:\temp\kodplan-line.shp
1129.27
1259.27
16.9639
17.9055
60
25
150
1379080
30
GET
Calculate
Show Plots
56 Numbers of Visible Agents
1532.311 Number of Grids
0.0365 TVR (Targeted Visibility Ratio)

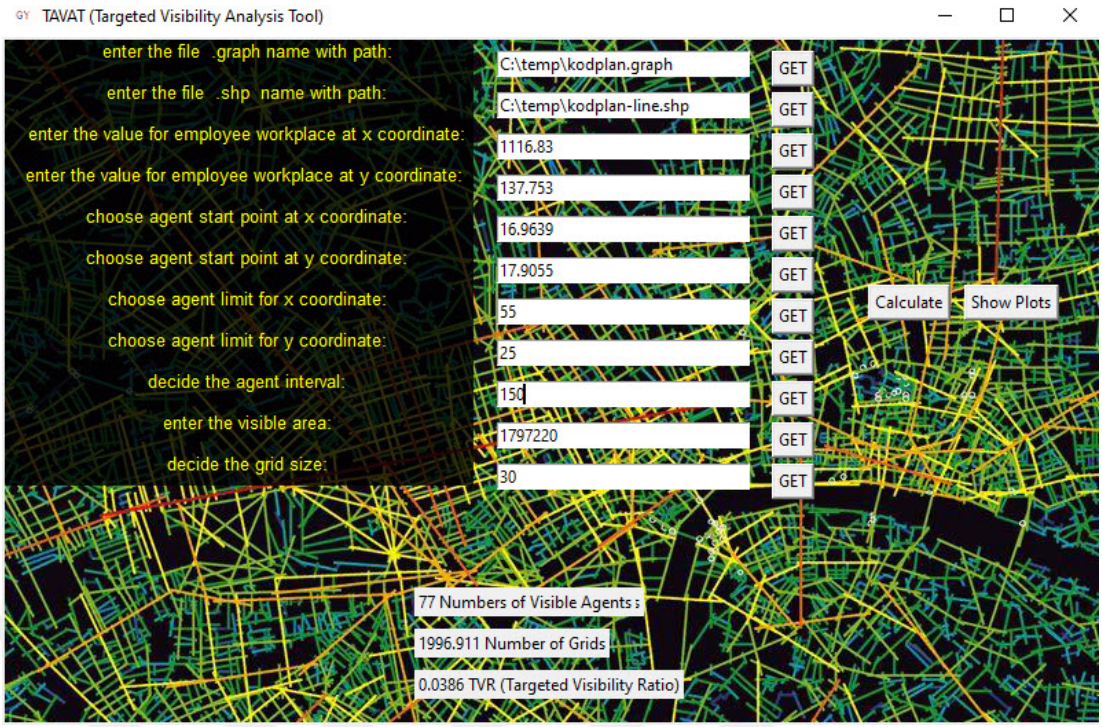

TAVAT (Targeted Visibility Analysis Tool)
enter the file .graph name with path:
enter the file .shp name with path:
enter the value for employee workplace at x coordinate:
enter the value for employee workplace at y coordinate:
choose agent start point at x coordinate:
choose agent start point at y coordinate:
choose agent limit for x coordinate:
choose agent limit for y coordinate:
decide the agent interval:
enter the visible area:
decide the grid size:
C:\temp\kodplan.graph
C:\temp\kodplan-line.shp
1129.27
1259.27
16.9639
17.9055
60
25
60
1379080
30
GET
Calculate
Show Plots
369 Numbers of Visible Agents
1532.311 Number of Grids
0.2408 TVR (Targeted Visibility Ratio)

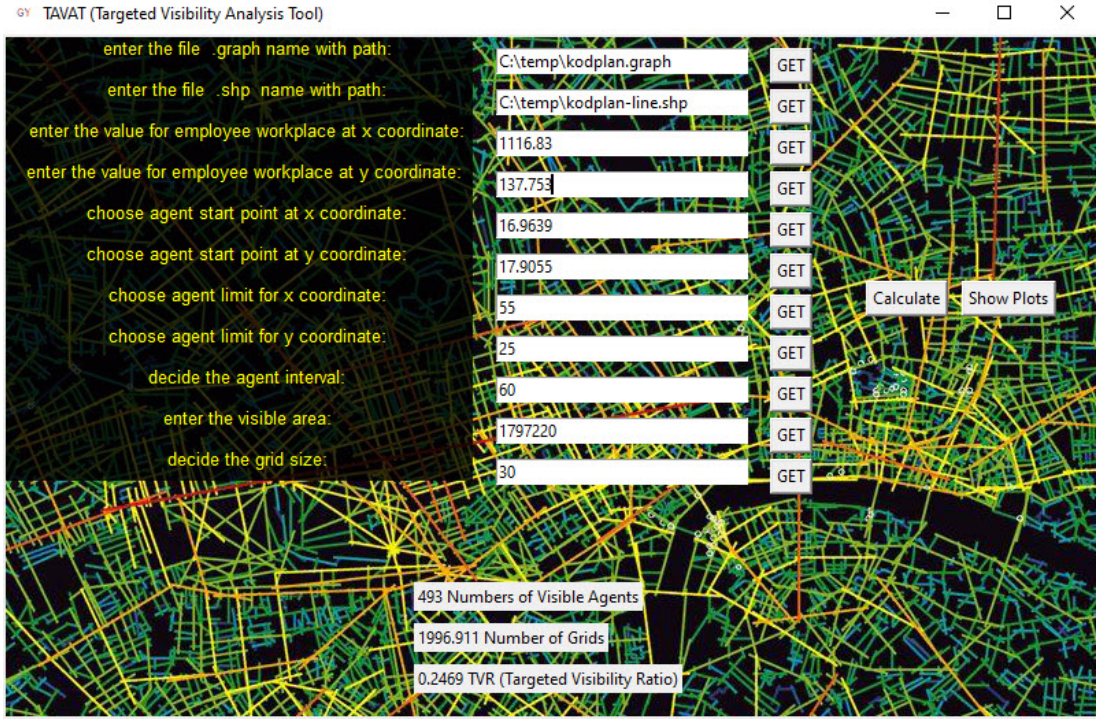

TAVAT (Targeted Visibility Analysis Tool)
enter the file .graph name with path:
C:\temp\kodplan.graph
GET
enter the file .shp name with path:
C:\temp\kodplan-line.shp
GET
enter the value for employee workplace at x coordinate:
1131.61
GET
enter the value for employee workplace at y coordinate:
1002.34
GET
choose agent start point at x coordinate:
16.9639
GET
choose agent start point at y coordinate:
17.9055
GET
choose agent limit for x coordinate:
55
GET
choose agent limit for y coordinate:
25
GET
decide the agent interval:
150
GET
enter the visible area:
267350
GET
decide the grid size:
30
GET
Calculate
Show Plots
10 Numbers of Visible Agents ;
297.056 Number of Grids ;
0.0337 TVR (Targeted Visibility Ratio)

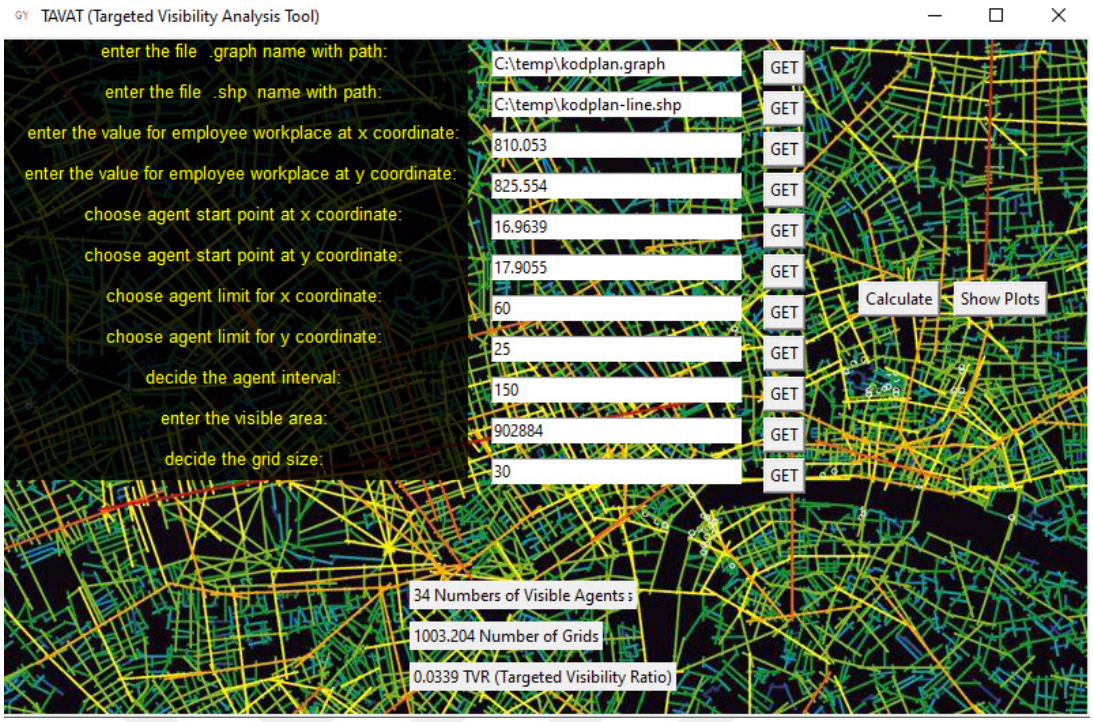

TAVAT (Targeted Visibility Analysis Tool)
enter the file .graph name with path:
C:\temp\kodplan.graph
GET
enter the file .shp name with path:
C:\temp\kodplan-line.shp
GET
enter the value for employee workplace at x coordinate:
1131.61
GET
enter the value for employee workplace at y coordinate:
1002.34
GET
choose agent start point at x coordinate:
16.9639
GET
choose agent start point at y coordinate:
17.9055
GET
choose agent limit for x coordinate:
55
GET
choose agent limit for y coordinate:
25
GET
decide the agent interval:
60
GET
enter the visible area:
267350
GET
decide the grid size:
30
GET
Calculate
Show Plots
65 Numbers of Visible Agents ;
297.056 Number of Grids ;
0.2188 TVR (Targeted Visibility Ratio)

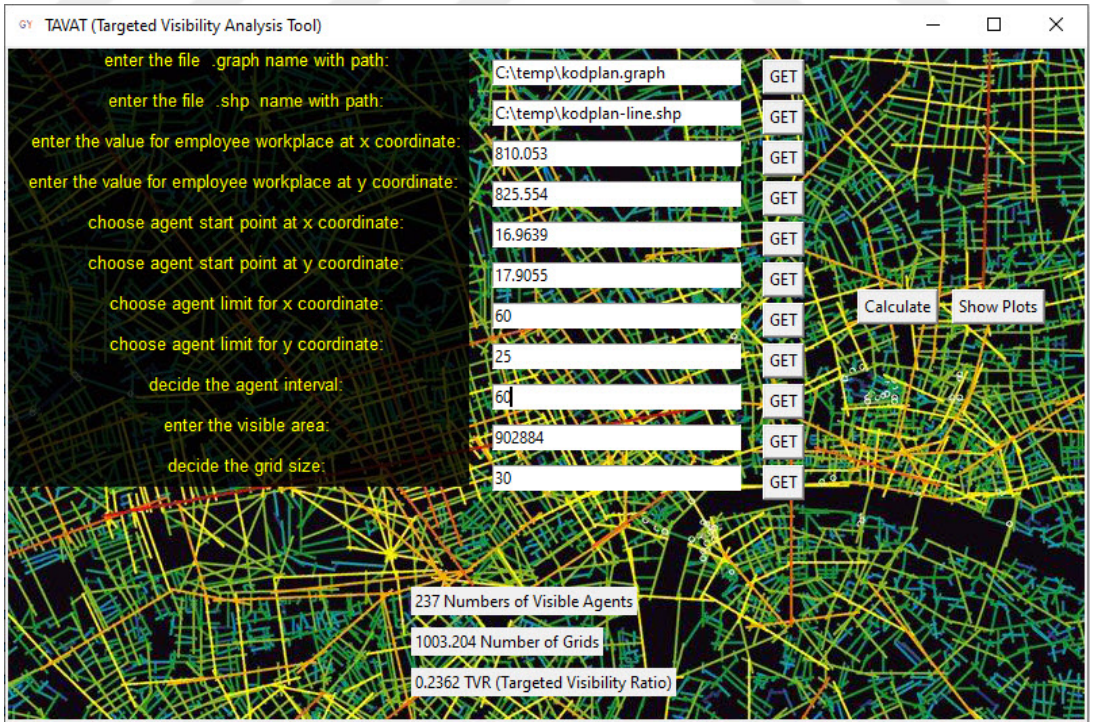

TAVAT (Targeted Visibility Analysis Tool)
enter the file .graph name with path:
enter the file .shp name with path:
enter the value for employee workplace at x coordinate:
enter the value for employee workplace at y coordinate:
choose agent start point at x coordinate:
choose agent start point at y coordinate:
choose agent limit for x coordinate:
choose agent limit for y coordinate:
decide the agent interval:
enter the visible area:
decide the grid size:
C:\temp\kodplan.graph
C:\temp\kodplan-line.shp
1327.44
137.753
16.9639
17.9055
55
25
150
1830160
30
GET
Calculate
Show Plots
82 Numbers of Visible Agents :
2033.511 Number of Grids
0.0403 TVR (Targeted Visibility Ratio)

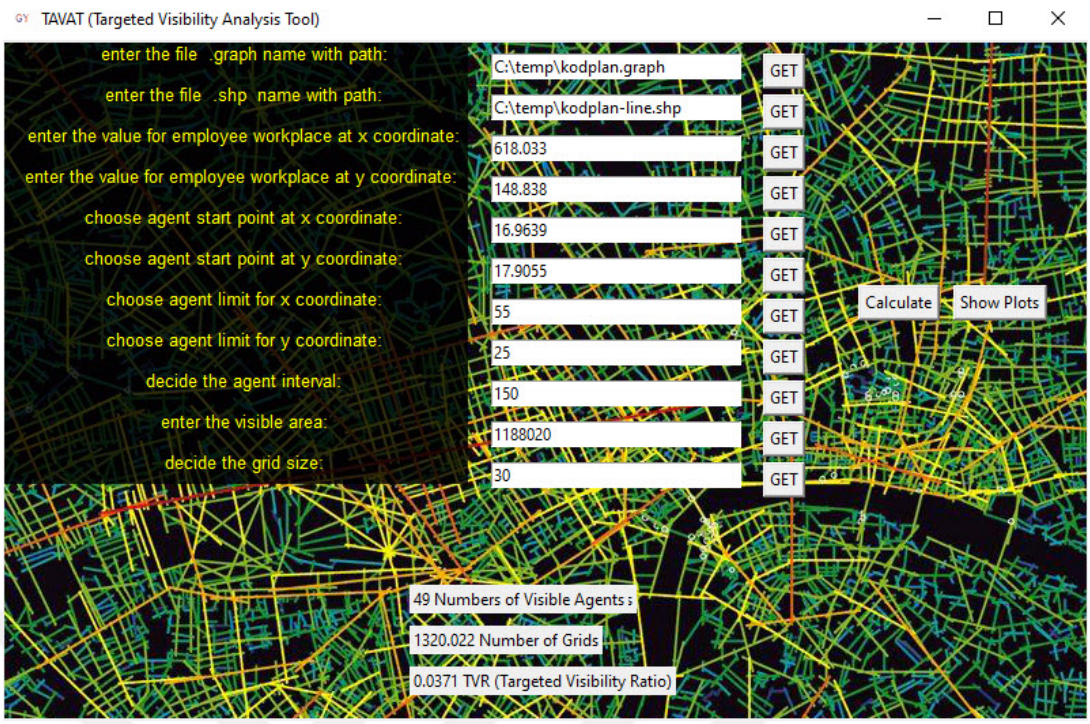

TAVAT (Targeted Visibility Analysis Tool)
enter the file .graph name with path:
enter the file .shp name with path:
enter the value for employee workplace at x coordinate:
enter the value for employee workplace at y coordinate:
choose agent start point at x coordinate:
choose agent start point at y coordinate:
choose agent limit for x coordinate:
choose agent limit for y coordinate:
decide the agent interval:
enter the visible area:
decide the grid size:
C:\temp\kodplan.graph
C:\temp\kodplan-line.shp
1327.44
137.753
16.9639
17.9055
55
25
60
1830160
30
GET
Calculate
Show Plots
521 Numbers of Visible Agents
2033.511 Number of Grids
0.2562 TVR (Targeted Visibility Ratio)

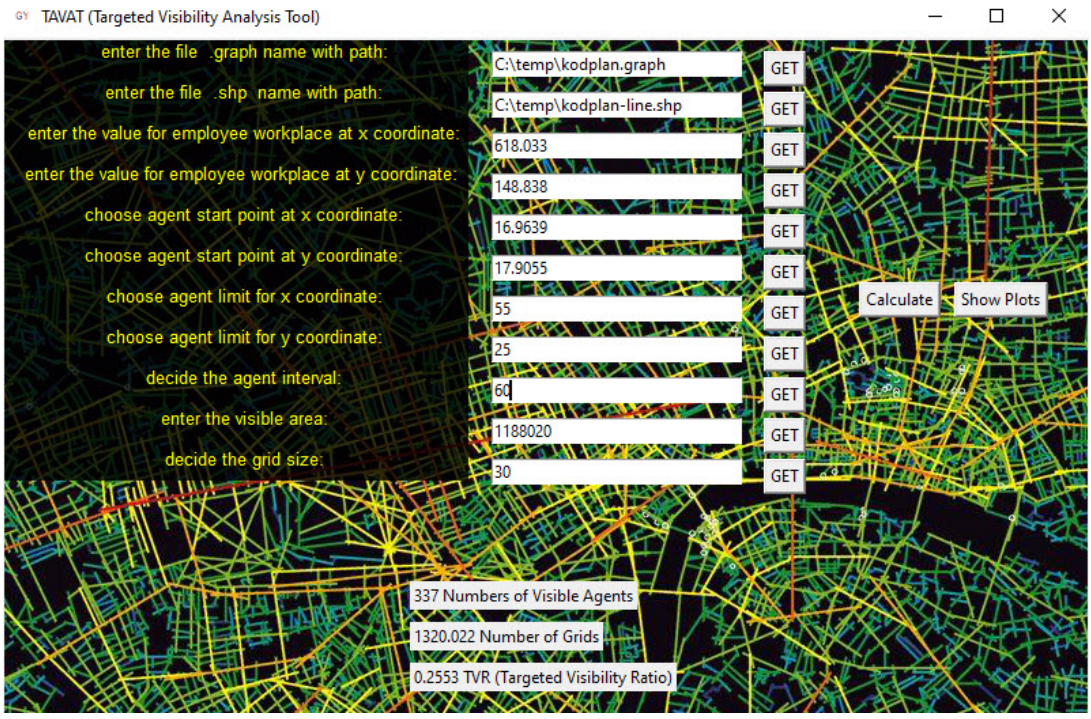

TAVAT (Targeted Visibility Analysis Tool)
enter the file .graph name with path:
enter the file .shp name with path:
enter the value for employee workplace at x coordinate:
enter the value for employee workplace at y coordinate:
choose agent start point at x coordinate:
choose agent start point at y coordinate:
choose agent limit for x coordinate:
choose agent limit for y coordinate:
decide the agent interval:
enter the visible area:
decide the grid size:
C:\temp\kodplan.graph
C:\temp\kodplan-line.shp
1116.83
137.753
16.9639
17.9055
55
25
150
1797220
30
GET
Calculate
Show Plots
77 Numbers of Visible Agents
1996.911 Number of Grids
0.0386 TVR (Targeted Visibility Ratio)


TAVAT (Targeted Visibility Analysis Tool)
enter the file .graph name with path:
enter the file .shp name with path:
enter the value for employee workplace at x coordinate:
enter the value for employee workplace at y coordinate:
choose agent start point at x coordinate:
choose agent start point at y coordinate:
choose agent limit for x coordinate:
choose agent limit for y coordinate:
decide the agent interval:
enter the visible area:
decide the grid size:
C:\temp\kodplan.graph
C:\temp\kodplan-line.shp
1116.83
137.753
16.9639
17.9055
55
25
60
1797220
30
GET
Calculate
Show Plots
493 Numbers of Visible Agents
1996.911 Number of Grids
0.2469 TVR (Targeted Visibility Ratio)


TAVAT (Targeted Visibility Analysis Tool)
enter the file .graph name with path:
enter the file .shp name with path:
enter the value for employee workplace at x coordinate:
enter the value for employee workplace at y coordinate:
choose agent start point at x coordinate:
choose agent start point at y coordinate:
choose agent limit for x coordinate:
choose agent limit for y coordinate:
decide the agent interval:
enter the visible area:
decide the grid size:
C:\temp\kodplan.graph
C:\temp\kodplan-line.shp
810.053
825.554
16.9639
17.9055
60
25
150
902884
30
GET
Calculate
Show Plots
34 Numbers of Visible Agents
1003.204 Number of Grids
0.0339 TVR (Targeted Visibility Ratio)


TAVAT (Targeted Visibility Analysis Tool)
enter the file .graph name with path:
enter the file .shp name with path:
enter the value for employee workplace at x coordinate:
enter the value for employee workplace at y coordinate:
choose agent start point at x coordinate:
choose agent start point at y coordinate:
choose agent limit for x coordinate:
choose agent limit for y coordinate:
decide the agent interval:
enter the visible area:
decide the grid size:
C:\temp\kodplan.graph
C:\temp\kodplan-line.shp
810.053
825.554
16.9639
17.9055
60
25
60
902884
30
GET
Calculate
Show Plots
237 Numbers of Visible Agents
1003.204 Number of Grids
0.2362 TVR (Targeted Visibility Ratio)


TAVAT (Targeted Visibility Analysis Tool)
enter the file .graph name with path:
enter the file .shp name with path:
enter the value for employee workplace at x coordinate:
enter the value for employee workplace at y coordinate:
choose agent start point at x coordinate:
choose agent start point at y coordinate:
choose agent limit for x coordinate:
choose agent limit for y coordinate:
decide the agent interval:
enter the visible area:
decide the grid size:
C:\temp\kodplan.graph
C:\temp\kodplan-line.shp
618.033
148.838
16.9639
17.9055
55
25
150
1188020
30
GET
Calculate
Show Plots
49 Numbers of Visible Agents
1320.022 Number of Grids
0.0371 TVR (Targeted Visibility Ratio)


TAVAT (Targeted Visibility Analysis Tool)
enter the file .graph name with path:
enter the file .shp name with path:
enter the value for employee workplace at x coordinate:
enter the value for employee workplace at y coordinate:
choose agent start point at x coordinate:
choose agent start point at y coordinate:
choose agent limit for x coordinate:
choose agent limit for y coordinate:
decide the agent interval:
enter the visible area:
decide the grid size:
C:\temp\kodplan.graph
C:\temp\kodplan-line.shp
618.033
148.838
16.9639
17.9055
55
25
60
1188020
30
GET
Calculate
Show Plots
337 Numbers of Visible Agents
1320.022 Number of Grids
0.2553 TVR (Targeted Visibility Ratio)

Appendix H. Eta Coefficient Tests for Öncüoğlu Architects

Directional Measures

			Value
Nominal by Interval	Eta	Duration of interaction Dependent	.784
		Interaction Dependent	.608

Directional Measures

			Value
Nominal by Interval	Eta	Number of employees Dependent	.701
		Interaction Dependent	.547

Directional Measures

			Value
Nominal by Interval	Eta	Planned/Unplanned Dependent	.667
		Interaction Dependent	.278

Directional Measures

			Value
Nominal by Interval	Eta	Type of the interaction Dependent	.612
		Interaction Dependent	.254

Directional Measures

			Value
Nominal by Interval	Eta	Main reason to interact Dependent	.776
		Interaction Dependent	.375

Directional Measures

			Value
Nominal by Interval	Eta	Team Dependent	.535
		Interaction Dependent	.070

Appendix I. Eta Coefficient Tests for Tepe Home

Directional Measures

			Value
Nominal by Interval	Eta	Duration of interaction Dependent	.628
		Interaction Dependent	.230

Directional Measures

			Value
Nominal by Interval	Eta	Number of employees Dependent	.564
		Interaction Dependent	.052

Directional Measures

			Value
Nominal by Interval	Eta	Planned/Unplanned Dependent	.829
		Interaction Dependent	.321

Directional Measures

			Value
Nominal by Interval	Eta	Type of interaction Dependent	.701
		Interaction Dependent	.138

Directional Measures

			Value
Nominal by Interval	Eta	Main reason to interact Dependent	.482
		Interaction Dependent	.526

Directional Measures

			Value
Nominal by Interval	Eta	team Dependent	.671
		Interaction Dependent	.285

Appendix J. Bootstrapped Pearson Correlation Analysis for Öncüoğlu Architects

Bootstrap Specifications

Sampling Method	Simple
Number of Samples	1000
Confidence Interval Level	95.0%
Confidence Interval Type	Bias-corrected and accelerated (BCa)

Correlations

				Degree	Density	Visual Integration	Outdegree	Binocular Density	TVR60	TVR150	Work-process Interaction
Degree	Pearson Correlation			1	.737**	.182	.407	.857**	.085	.350	-.544*
	Sig. (2-tailed)				.003	.534	.149	.000	.773	.220	.044
	N			14	14	14	14	14	14	14	14
	Bootstrap[c]	Bias		0	-.014	-.061	-.007	-.009	.008	.013	.033
		Std. Error		0	.169	.374	.189	.078	.172	.194	.234
		95% Confidence Interval	Lower	1	.284	-.643	-.030	.658	-.232	-.052	-.847
			Upper	1	.918	.776	.729	.936	.476	.732	.149
Density	Pearson Correlation			.737**	1	-.480	.269	.796**	.119	.249	-.835**
	Sig. (2-tailed)			.003		.083	.352	.001	.685	.391	.000
	N			14	14	14	14	14	14	14	14
	Bootstrap[c]	Bias		-.014	0	-.027	-.003	-.044	-.029	.014	.044
		Std. Error		.169	0	.225	.219	.180	.252	.241	.143
		95% Confidence Interval	Lower	.284	1	-.893	-.201	.288	-.441	-.272	-.946
			Upper	.918	1	-.059	.667	.953	.578	.701	-.401
Visual Integration	Pearson Correlation			.182	-.480	1	.223	-.003	-.020	.078	.444
	Sig. (2-tailed)			.534	.083		.444	.992	.945	.791	.112
	N			14	14	14	14	14	14	14	14
	Bootstrap[c]	Bias		-.061	-.027	0	-.036	-.022	.021	.020	.016
		Std. Error		.374	.225	0	.269	.349	.194	.221	.182
		95% Confidence Interval	Lower	-.643	-.893	1	-.378	-.719	-.342	-.310	.114
			Upper	.776	-.059	1	.689	.597	.397	.559	.857
Outdegree	Pearson Correlation			.407	.269	.223	1	.635*	-.550*	-.395	-.129
	Sig. (2-tailed)			.149	.352	.444		.015	.042	.163	.661
	N			14	14	14	14	14	14	14	14
	Bootstrap[c]	Bias		-.007	-.003	-.036	0	.009	.031	.022	.003
		Std. Error		.189	.219	.269	0	.107	.217	.258	.321
		95% Confidence Interval	Lower	-.030	-.201	-.378	1	.405	-.812	-.794	-.685
			Upper	.729	.667	.689	1	.825	.033	.170	.570
Binocular Density	Pearson Correlation			.857**	.796**	-.003	.635*	1	-.026	.102	-.639*
	Sig. (2-tailed)			.000	.001	.992	.015		.931	.728	.014
	N			14	14	14	14	14	14	14	14
	Bootstrap[c]	Bias		-.009	-.044	-.022	.009	0	.013	.037	.077
		Std. Error		.078	.180	.349	.107	0	.215	.249	.287
		95% Confidence Interval	Lower	.658	.288	-.719	.405	1	-.429	-.261	-.919
			Upper	.936	.953	.597	.825	1	.519	.720	.216
TVR60	Pearson Correlation			.085	.119	-.020	-.550*	-.026	1	.786**	-.319
	Sig. (2-tailed)			.773	.685	.945	.042	.931		.001	.267
	N			14	14	14	14	14	14	14	14
	Bootstrap[c]	Bias		.008	-.029	.021	.031	.013	0	-.062	.035
		Std. Error		.172	.252	.194	.217	.215	0	.197	.312
		95% Confidence Interval	Lower	-.232	-.441	-.342	-.812	-.429	1	.233	-.792
			Upper	.476	.578	.397	.033	.519	1	.944	.430
TVR150	Pearson Correlation			.350	.249	.078	-.395	.102	.786**	1	-.171
	Sig. (2-tailed)			.220	.391	.791	.163	.728	.001		.559
	N			14	14	14	14	14	14	14	14
	Bootstrap[c]	Bias		.013	.014	.020	.022	.037	-.062	0	.026
		Std. Error		.194	.241	.221	.258	.249	.197	0	.299
		95% Confidence Interval	Lower	-.052	-.272	-.310	-.794	-.261	.233	1	-.724
			Upper	.732	.701	.559	.170	.720	.944	1	.450
Work-process Interaction	Pearson Correlation			-.544*	-.835**	.444	-.129	-.639*	-.319	-.171	1
	Sig. (2-tailed)			.044	.000	.112	.661	.014	.267	.559	
	N			14	14	14	14	14	14	14	14
	Bootstrap[c]	Bias		.033	.044	.016	.003	.077	.035	.026	0
		Std. Error		.234	.143	.182	.321	.287	.312	.299	0
		95% Confidence Interval	Lower	-.847	-.946	.114	-.685	-.919	-.792	-.724	1
			Upper	.149	-.401	.857	.570	.216	.430	.450	1

**. Correlation is significant at the 0.01 level (2-tailed).

*. Correlation is significant at the 0.05 level (2-tailed).

c. Unless otherwise noted, bootstrap results are based on 1000 bootstrap samples

Appendix K. Bootstrapped Pearson Correlation Analysis for Tepe Home

Bootstrap Specifications	
Sampling Method	Simple
Number of Samples	1000
Confidence Interval Level	95.0%
Confidence Interval Type	Bias-corrected and accelerated (BCa)

Correlations

				Degree	Density	visual integration	Outdegree	Binocular density	tvr60	tvr150	Work interaction
Degree	Pearson Correlation			1	-.663**	.725**	-.221	.233	-.060	-.191	.143
	Sig. (2-tailed)				.007	.002	.429	.404	.832	.495	.612
	N			15	15	15	15	15	15	15	15
	Bootstrap[d]	Bias		0	-.082[e]	-.042	.005	-.009	.017	-.006	-.048
		Std. Error		0	.107[e]	.188	.216	.196	.257	.200	.313
		95% Confidence Interval	Lower	1	-.946[e]	.153	-.611	-.252	-.490	-.581	-.533
			Upper	1	-.544[e]	.903	.260	.569	.557	.249	.639
Density	Pearson Correlation			-.663**	1	-.578*	.087	-.054	-.127	.026	-.418
	Sig. (2-tailed)			.007		.024	.759	.849	.653	.927	.121
	N			15	15	15	15	15	15	15	15
	Bootstrap[d]	Bias		-.082[e]	0[e]	-.089[e]	.009[e]	.010[e]	-.060[e]	-.003[e]	-.086[e]
		Std. Error		.107[e]	0[e]	.096[e]	.109[e]	.100[e]	.146[e]	.104[e]	.127[e]
		95% Confidence Interval	Lower	-.946[e]	1[e]	-.874[e]	-.111[e]	-.204[e]	-.580[e]	-.201[e]	-.768[e]
			Upper	-.544[e]	1[e]	-.499[e]	.305[e]	.211[e]	.025[e]	.211[e]	-.300[e]
visual integration	Pearson Correlation			.725**	-.578*	1	-.073	.335	.137	-.081	.225
	Sig. (2-tailed)			.002	.024		.796	.222	.626	.774	.420
	N			15	15	15	15	15	15	15	15
	Bootstrap[d]	Bias		-.042	-.089[e]	0	.041	-.086	.045	.084	.021
		Std. Error		.188	.096[e]	0	.286	.310	.318	.382	.324
		95% Confidence Interval	Lower	.153	-.874[e]	1	-.510	-.350	-.483	-.602	-.440
			Upper	.903	-.499[e]	1	.610	.728	.757	.750	.775
Outdegree	Pearson Correlation			-.221	.087	-.073	1	-.533*	.447	.827**	.116
	Sig. (2-tailed)			.429	.759	.796		.041	.094	.000	.680
	N			15	15	15	15	15	15	15	15
	Bootstrap[d]	Bias		.005	.009[e]	.041	0	.031	-.022	.010	.011
		Std. Error		.216	.109[e]	.286	0	.260	.290	.061	.318
		95% Confidence Interval	Lower	-.611	-.111[e]	-.510	1	-.908	-.231	.708	-.489
			Upper	.260	.305[e]	.610	1	.235	.906	.937	.758
Binocular density	Pearson Correlation			.233	-.054	.335	-.533*	1	-.580*	-.566*	-.634*
	Sig. (2-tailed)			.404	.849	.222	.041		.023	.028	.011
	N			15	15	15	15	15	15	15	15
	Bootstrap[d]	Bias		-.009	.010[e]	-.086	.031	0	.111	.119	.021
		Std. Error		.196	.100[e]	.310	.260	0	.407	.367	.185
		95% Confidence Interval	Lower	-.252	-.204[e]	-.350	-.908	1	-.847	-.880	-.880
			Upper	.569	.211[e]	.728	.235	1	.718	.565	-.115
tvr60	Pearson Correlation			-.060	-.127	.137	.447	-.580*	1	.697**	.681**
	Sig. (2-tailed)			.832	.653	.626	.094	.023		.004	.005
	N			15	15	15	15	15	15	15	15
	Bootstrap[d]	Bias		.017	-.060[e]	.045	-.022	.111	0	-.013	-.018
		Std. Error		.257	.146[e]	.318	.290	.407	0	.173	.163
		95% Confidence Interval	Lower	-.490	-.580[e]	-.483	-.231	-.847	1	.242	.217
			Upper	.557	.025[e]	.757	.906	.718	1	.920	.882
tvr150	Pearson Correlation			-.191	.026	-.081	.827**	-.566*	.697**	1	.364
	Sig. (2-tailed)			.495	.927	.774	.000	.028	.004		.182
	N			15	15	15	15	15	15	15	15
	Bootstrap[d]	Bias		-.006	-.003[e]	.084	.010	.119	-.013	0	-.031
		Std. Error		.200	.104[e]	.382	.061	.367	.173	0	.267
		95% Confidence Interval	Lower	-.581	-.201[e]	-.602	.708	-.880	.242	1	-.271
			Upper	.249	.211[e]	.750	.937	.565	.920	1	.762
Work interaction	Pearson Correlation			.143	-.418	.225	.116	-.634*	.681**	.364	1
	Sig. (2-tailed)			.612	.121	.420	.680	.011	.005	.182	
	N			15	15	15	15	15	15	15	15
	Bootstrap[d]	Bias		-.048	-.086[e]	.021	.011	.021	-.018	-.031	0
		Std. Error		.313	.127[e]	.324	.318	.185	.163	.267	0
		95% Confidence Interval	Lower	-.533	-.768[e]	-.440	-.489	-.880	.217	-.271	1
			Upper	.639	-.300[e]	.775	.758	-.115	.882	.762	1

**. Correlation is significant at the 0.01 level (2-tailed).

*. Correlation is significant at the 0.05 level (2-tailed).

d. Unless otherwise noted, bootstrap results are based on 1000 bootstrap samples

e. Based on 657 samples

Appendix L. Regression Analyses for Öncüoğlu Architects

Variables Entered/Removed[a]

Model	Variables Entered	Variables Removed	Method
1	Visual Integration, Degree, Density	.	Enter

a. Dependent Variable: Interaction
b. All requested variables entered.

Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	,841[a]	,707	,627	1,07323

a. Predictors: (Constant), Visual Integration, Degree, Density

ANOVA[a]

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	30,586	3	10,195	8,852	,003[b]
	Residual	12,670	11	1,152		
	Total	43,256	14			

a. Dependent Variable: Interaction
b. Predictors: (Constant), Visual Integration, Degree, Density

Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients		
		B	Std. Error	Beta	t	Sig.
1	(Constant)	17,935	4,163		4,308	,001
	Degree	,176	,188	,533	,938	,368
	Density	-63,237	28,683	-1,417	-2,205	,050
	Visual Integration	-,134	,144	-,460	-,925	,375

a. Dependent Variable: Interaction

Variables Entered/Removed[a]

Model	Variables Entered	Variables Removed	Method
1	TVR150, Binocular Density, Outdegree, TVR60[b]	.	Enter

a. Dependent Variable: Interaction

b. All requested variables entered.

Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.795[a]	.632	.468	1.32746

a. Predictors: (Constant), TVR150, Binocular Density, Outdegree, TVR60

ANOVA[a]

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	27.185	4	6.796	3.857	.043[b]
	Residual	15.859	9	1.762		
	Total	43.044	13			

a. Dependent Variable: Interaction

b. Predictors: (Constant), TVR150, Binocular Density, Outdegree, TVR60

Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	30.941	14.991		2.064	.069
	Outdegree	.172	.169	.372	1.021	.334
	Binocular Density	-36.718	12.150	-.936	-3.022	.014
	TVR60	-94.270	68.793	-.508	-1.370	.204
	TVR150	162.539	116.114	.470	1.400	.195

a. Dependent Variable: Interaction

Appendix M. Regression Analyses for Tepe Home

Variables Entered/Removed[a]

Model	Variables Entered	Variables Removed	Method
1	visual integration, Density, Degree[b]	.	Enter

a. Dependent Variable: Interaction

b. All requested variables entered.

Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	,465[a]	,217	,003	1,22482

a. Predictors: (Constant), visual integration, Density, Degree

ANOVA[a]

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	4,565	3	1,522	1,014	,423[b]
	Residual	16,502	11	1,500		
	Total	21,067	14			

a. Dependent Variable: Interaction

b. Predictors: (Constant), Visual integration, Density, Degree

Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	27,923	18,204		1,534	,153
	Degree	-,314	,412	-,328	-,762	,462
	Density	-262,535	172,397	-,553	-1,523	,156
	Visual integration	,012	,034	,144	,364	,723

a. Dependent Variable: Interaction

Variables Entered/Removed[a]

Model	Variables Entered	Variables Removed	Method
1	tvr150, Binocular density, tvr60, Outdegree[b]	.	Enter

a. Dependent Variable: Work interaction

b. All requested variables entered.

Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	,819[a]	,671	,539	,83274

a. Predictors: (Constant), tvr150, Binocular density, tvr60, Outdegree

ANOVA

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	14,132	4	3,533	5,095	,017[b]
	Residual	6,935	10	,693		
	Total	21,067	14			

a. Dependent Variable: Work interaction

b. Predictors: (Constant), tvr150, Binocular density, tvr60, Outdegree

Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	-8,835	6,616		-1,335	,211
	Outdegree	-,127	,092	-,485	-1,373	,200
	Binocular density	-31,788	14,303	-,535	-2,223	,050
	tvr60	55,671	31,258	,515	1,781	,105
	tvr150	44,807	183,698	,104	,244	,812

a. Dependent Variable: Work interaction