Załącznik nr 1/1
do Zarządzenia Rektora PG nr 30/2022 z 14 kwietnia 2022 r.

POLITECHNIKA GDAŃSKA

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Dyscyplina naukowa: Architektura i urbanistyka

ROZPRAWA DOKTORSKA

Tytuł rozprawy w języku polskim: Poszukiwanie zależności między doświetleniem naturalnym a zachowaniem użytkowników: badania empiryczne współczesnych bibliotek publicznych w Trójmieście

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Gdańsk, 2026

Załącznik nr 1/2
do Zarządzenia Rektora PG nr 30/2022 z 14 kwietnia 2022 r.

GDAŃSK UNIVERSITY OF TECHNOLOGY

The author of the doctoral dissertation: M.Sc. Eng. Arch. Mosleh Ahmadi
Scientific discipline: Architecture and Urban Planning

DOCTORAL DISSERTATION

Title of doctoral dissertation: Exploring the Relationship Between Daylighting and User Behavior: An Empirical Study of Contemporary Public Libraries in the Tri-City

Supervisor	**Auxiliary supervisor**
Signature	Signature
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Gdańsk, 2026

Załącznik nr 2/1
do Zarządzenia Rektora PG nr 30/2022 z 14 kwietnia 2022 r.

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Autor rozprawy doktorskiej: mgr inż. arch. Mosleh Ahmadi

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Tytuł rozprawy doktorskiej w języku polskim: Poszukiwanie zależności między doświetleniem naturalnym a zachowaniem użytkowników: badania empiryczne współczesnych bibliotek publicznych w Trójmieście

Język rozprawy doktorskiej: Angielski

Promotor rozprawy doktorskiej: dr hab. inż. arch. Justyna Martyniuk-Pęczek, prof. PG

Promotor pomocniczy rozprawy doktorskiej: dr. Natalia Sokół

Data obrony:

Słowa kluczowe rozprawy doktorskiej w języku polskim: architektura współczesna; doświetlenie naturalne; ruch użytkowników; biblioteka; Space Syntax

Streszczenie rozprawy w języku polskim: We współczesnych badaniach nad światłem dziennym w architekturze najczęściej podejmowane są zagadnienia jego wpływu na komfort użytkowników i efektywność budynków. Większość dotychczasowych badań koncentruje się na przestrzeniach biurowych, podczas gdy biblioteki pozostają wciąż niedostatecznie rozpoznane w literaturze przedmiotu.

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Wyniki wskazują, że układ przestrzenny stanowi główny czynnik kształtujący relację między warunkami oświetlenia dziennego a ruchem użytkowników. W przestrzeniach otwartych zależności między widocznością, dostępem do światła dziennego, olśnieniem a ruchem były wyraźniejsze, natomiast w przestrzeniach podzielonych na strefy funkcjonalne ruch użytkowników był bardziej równomiernie rozłożony, a wpływ oświetlenia dziennego mniej wyraźny. Dodatkowo zaobserwowano, że sezonowe zmiany oświetlenia dziennego wpływały na modyfikację tych zależności, oddziałując na sposób korzystania z przestrzeni przez użytkowników. Wyniki pracy doktorskiej wskazują na kluczową rolę układu przestrzennego w sposobie użytkowania przestrzeni w kontekście oświetlenia dziennego. Wskazują również, że integracja danych subiektywnych, obserwacyjnych i obliczeniowych pozwala na pełniejszą ocenę jakości oraz funkcjonalności przestrzeni. Jednocześnie, aby lepiej zrozumieć różnice między układami otwartymi a podzielonymi na strefy, konieczne są dalsze studia przypadków.

GDAŃSK UNIVERSITY OF TECHNOLOGY

DESCRIPTION OF DOCTORAL DISSERTATION

The Author of the doctoral dissertation: M.Sc. Eng. Arch. Mosleh Ahmadi

Title of doctoral dissertation: Exploring the Relationship Between Daylighting and User Behavior: An Empirical Study of Contemporary Public Libraries in the Tri-City

Language of doctoral dissertation: English

Supervisor: Dr Hab. Eng. Arch. Justyna Martyniuk-Pęczek

Auxiliary supervisor: Dr. Natalia Sokół

Date of doctoral defense:

Keywords of doctoral dissertation in English: Contemporary Architecture; Daylighting; User Movement; Library Building; Space Syntax

Summary of doctoral dissertation in English: In contemporary research on daylighting in architecture, the most frequently addressed issues concern its impact on visual aspects, building energy efficiency, environmental performance, and user comfort. Most existing studies focus on office environments, while libraries remain insufficiently explored in the literature.

This study analyzes the relationships between access to daylight and user behavior in library spaces, employing a mixed-method research framework. In the first stage, a systematic literature review was conducted to develop a conceptual framework and define key methodological parameters. Based on this, four main dimensions of user activity were identified: spatial utilization, place preferences, movement trajectories and transitions, and temporal patterns of space use. Empirical research was carried out in two public libraries built in recent years, representing contemporary architecture practice. The first has an open-plan layout (with a minimal number of walls and barriers), while the second is divided into functional zones (with glass partitions and walls). In both cases, analogous studies were conducted with the participation of space users (both visitors and librarians). Data were collected through questionnaires and structured behavioral mapping, including the recording of spatial occupancy, movement intensity, and duration of stay that led to the introduction of two research-defined indicators Movement Intensity, and Spatial Efficacy. In the second phase of the study, daylight simulations (through AnnuOWL) and spatial configuration analyses (through DepthmapX) were performed. A key contribution of the research is the integration of these datasets through a spatially analytical framework, in which daylight metrics, space syntax measures, and observed behavioral patterns were assigned to corresponding spatial locations and analyzed jointly. The data collected in both phases were then subjected to statistical analysis, including non-parametric tests using Jamovi and Spearman's rank correlation method.

The results indicate that spatial layout is the main factor shaping the relationship between daylight conditions and user movement. In open-plan spaces, relationships between visibility, daylight access, glare, and movement were more pronounced, whereas in spaces divided into functional zones, user movement was more evenly distributed and the influence of daylight was less evident. Additionally, seasonal variations in daylight were found to modify these relationships, affecting how users interact with space. The findings highlight the importance of considering daylight as part of a broader spatial-behavioral system and demonstrate that the integration of observational, subjective, and simulation-based data enables a more comprehensive evaluation of spatial performance and user experience. At the same time, further case studies are needed to better understand the differences between open-plan and segmented layouts.

EXPLORING THE RELATIONSHIP BETWEEN DAYLIGHTING AND USER BEHAVIOR:

AN EMPRIRICAL STUDY OF CONTEMPORARY PUBLIC LIBRARIES IN THE TRI-CITY

Doctoral Dissertation
by

Mosleh Ahmadi

Thesis Supervisors

dr hab. inż. arch. **Justyna Martyniuk-Pęczek**, prof. PG
dr **Natalia Sokół**

CONTENTS

Epigraph (Kurdish)

"لەو پەنجەرەیەوە شتێکم بینی گەر بهاتبایە و نەمدیایە نە دەژیام... من لەو پەنجەرەیەوە بەختەوەری بیابانم بینی، یاری تیشک و لمم بینی...

مرۆڤ دەبێت تا دوا هەناسە، تا دوا مردنیش باوەڕی بە بەختیاری خۆی نەدۆڕێنێت، باوەڕی خۆی بە جوانی لە دەست نەدا."

- بە ختیار عە لی، دواهە مین هە ناری دونیا، ل ١٨٨–١٨٩

Polish version:

„Z tego okna zobaczyłem coś, co gdyby przyszło, a ja bym tego nie zobaczył, nie żyłbym... Z tego okna zobaczyłem szczęście pustyni, grę światła i piasek...

Człowiek aż do ostatniego oddechu, nawet po śmierci nie powinien utracić wiary we własne Błogość i nie powinien porzucić wiary w piękno."

- Bachtyar Ali, Ostatnie drzewo granatu, ss. 188–189

English version:

"From that window I saw something that, had it come and I not seen it, I would not have lived... From that window I saw the happiness of the desert, the play of light and sand...

A human being must, until their last breath, even after their death, not lose faith in their own bliss, and must not let go of their belief in beauty."

- Bachtyar Ali, The Last Pomegranate Tree, pp. 188–189

Abstract

In contemporary research on daylighting in architecture, the most frequently addressed issues concern its impact on visual aspects, building energy efficiency, environmental performance, and user comfort. Most existing studies focus on office environments, while libraries remain insufficiently explored in the literature.

This study analyzes the relationships between access to daylight and user behavior in library spaces, employing a **mixed-method research framework**. In the first stage, a systematic literature review was conducted to develop a conceptual framework and define key methodological parameters. Based on this, four main dimensions of user activity were identified: spatial utilization, place preferences, movement trajectories and transitions, and temporal patterns of space use. Empirical research was carried out in two public libraries built in recent years, representing contemporary architecture practice. The first has an open-plan layout (with a minimal number of walls and barriers), while the second is divided into functional zones (with glass partitions and walls). In both cases, analogous studies were conducted with the participation of space users (both visitors and librarians). Data were collected through **questionnaires** and **structured behavioral mapping**, including the recording of spatial occupancy, movement intensity, and duration of stay that led to the introduction of two research-defined indicators **Movement Intensity**, and **Spatial Efficacy**. In the second phase of the study, **daylight simulations** (through AnnuOWL) and **spatial configuration analyses** (through DepthmapX) were performed. A key contribution of the research is the integration of these datasets through a spatially analytical framework, in which daylight metrics, space syntax measures, and observed behavioral patterns were assigned to corresponding spatial locations and analyzed jointly. The data collected in both phases were then subjected to statistical analysis, including **non-parametric tests** using Jamovi and **Spearman's rank correlation** method.

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Keywords: Contemporary Architecture; Daylighting; User Movement; Library Building; Space Syntax

Acknowledgments

I would like to sincerely thank my supervisor, Professor Justyna Martyniuk-Pęczek, for her support at the start of my PhD, particularly with my visa application, as well as for her guidance and helps throughout the research process. I also acknowledge my co-supervisor, Dr Natalia Sokol, for her formal role and valuable comments in this PhD.

I am deeply grateful to Dr Marshal Maskarenj from UCLouvain for his lectures, advice, and for introducing me to his brilliant software AnnuOWL for daylight analysis and for his guidance in its use during my research. I thank Professor Cláudia Naves David Amorim from University of Brasilia for her valuable feedbacks on my work. I also thank Dr Adam Bladowski for his valuable introductions and support with Python scripts, Hazhir Mirzaei for his guidance on 3D representations, and Joanna Francuzik for her help in translating academic texts. In addition, I thank Dr Parinaz Sabet for her valuable feedback on the graphical presentations.

I would like to thank Politechnika Gdańska, Faculty of Architecture, and the Doctoral School for providing me with the academic environment, resources, and support necessary to conduct my research.

I would like to sincerely thank Gdynia City Hall and the Gdynia Library, as well as the staff of the Maly Kack and Witomino libraries, for their responses and support during my survey. Special gratitude goes to Barbara Grzenia (Senior Curator), Joanna Mienik (Curator), Małgorzata Milewska (Librarian), Weronika Piróg (Junior Librarian), and Angelika Jędryka (Librarian) for their exceptional help at the Maly Kack library.

I wish to express my deepest gratitude to my parents, Zhila Haji Mirzaei and Ahmad Ahmadi, for their unwavering support, encouragement, and belief in me throughout my life and academic journey. Their love and guidance have been my foundation. I am also grateful to the rest of my family, Faruq and Mostafa, for their supports.

Above all, I want to give my heartfelt thanks to my newlywed wife, Oktawia Tysarczyk. Her support has gone far beyond any expectations - I could not have completed this thesis without her. She accompanied me during surveys, helped with translations, facilitated communication with librarians and library users, and contributed her patience, kindness, and wisdom at every step. More importantly, her emotional and mental support, her encouragement during moments of doubt, and her unwavering love have been my greatest source of strength. **Oktawia**, this achievement is as much yours as it is mine.

Introduction

“Daylight has always interested [him] more than walls and floors and the like, because daylight is what controls how people move through spaces.”
So spoke Henning Larsen, architect of the Gentofte Library, as recalled by Jørgensen et al. (2012).

I. Research Problem and Relevance

Human-centered, behavioral, and spatial experience studies, alongside sustainability and environmental performance, are two research directions that have gained increasing attention in architectural studies (Javid Khan and Lucas, 2025). Within the sustainability and environmental performance domain, daylighting research has become an important area of focus (Reinhart et al. 2006), reflecting growing concerns with energy efficiency, and occupant comfort (Çataroğlu Coğul et al. 2025). At the same time, studies of user behavior and spatial experience have expanded (Roofigari Esfahan & Morshedzadeh, 2025), addressing how architectural environments influence movement, use patterns, and everyday interactions with space. Despite these advances, most daylighting research has focused on offices and educational facilities, leaving a gap in understanding how daylight shapes user behavior at the micro-scale of individual interior spaces, such as library reading areas. This represents the primary problem this study seeks to address.

Daylighting has been considered an important parameter of architectural design to be considered. Studies such as the work of Turan et al. (2024) demonstrates that the integration of daylight in architectural design is associated not only with social and well-being benefits but also with measurable economic value for buildings. The findings of that study suggest that daylight should be considered an integral design parameter throughout all stages of the design process. Role of daylight in shaping user experience in architecture has shaped many recent studies. In her book, Lisa Heschong (2021) examines the role of daylight and views in shaping human experience within architectural spaces, with an attention to educational and institutional buildings such as schools and libraries. In a part of her book, Heschong highlights the Science and Engineering Library at UC Santa Cruz, where floor-to-ceiling corner windows bring in daylight through the surrounding redwoods, creating inviting study areas. Users consistently preferred these spaces, showing that daylight supports concentration, reflection, and well-being. Such design enhances both the functional and aesthetic quality of the library and contributes to its long-term social and cultural significance. Furthermore, public libraries have evolved from primarily silent, book-oriented spaces to multifunctional environments supporting social interaction, collaborative learning, and community activities (Mady & Hewidy, 2024). This evolution makes them a particularly relevant context for studying the interplay between daylighting and user movement.

This dissertation could be conceptually positioned within the context of ‘Human Factors in Lighting’ authored by Boyce (2014), complementing the book’s discussions on the relationship between daylighting conditions, and user movement. Within the book's structure, it could relate to discussions on lighting and the perception of spaces, visual comfort and discomfort, while drawing on daylighting discussions previously examined in office settings and considering their relevance to public library buildings. In this dissertation, user movement is examined through measures such as time spent in particular locations, relocation patterns, and place preference, addressing aspects of behavioral response to daylight that are not a central focus of Boyce's framework. The use of daylight simulation in combination with observation, surveys, and questionnaires links perceptual considerations to spatial and temporal patterns of use. By focusing on the micro-scale of library reading rooms, this study examines behavioral patterns and movement in ways that have been underexplored in daylighting research, which typically prioritizes building or façade-scale analysis. Overall, the study aligns with existing human-factors lighting literature as an applied architectural investigation into how daylighting conditions relate to movement and occupancy in public interior spaces such as libraries. Through this approach, the research contributes both to academic knowledge - by expanding understanding of micro-scale daylighting effects - and to architectural practice, by providing insights for designing library interiors that enhance user comfort, productivity, and social interaction.

II. Rationale for the Study: Motivation and Justification of the Research Topic

In recent years, there has been a growing interest in studying user movement within buildings (Liu et al., 2025; Aktan Abraham et al., 2025). A variety of tools have been developed to analyze or simulate this aspect of spatial use in architecture, particularly through space syntax methods (Safizadeh, 2024; Keleş et al., 2023; Omer & Goldblatt, 2017). Concurrently, daylighting has emerged as a key sustainable strategy, not only for energy savings and enhancing visual comfort (Hosseini et al., 2024) but also for supporting health and well-being (Mukherjee & Boubekri, 2025; He et al., 2025) and improving mood and productivity (Xu et al., 2025; Qi et al., 2024). While a substantial body of research exists on both user movement and daylighting, most studies focus on office or residential buildings, with relatively few investigations addressing library environments, highlighting a gap in the literature.

The focus of this dissertation is on contemporary libraries, specifically those built in the 21st century. The year 2004 marks a symbolic shift in library design, reflecting the diversification of their roles and functions. For instance, the Seattle Central Library, completed in 2004, exemplifies the 21st-century library not only through its innovative architectural form but also through the duality of user experience it provides (Lushington et al., 2019, pp. 12, 154) (Fig 1). This year is also significant in the context of the case studies examined in this thesis because 2004 marked Poland's accession to the European Union, which opened opportunities for increased internationalization and the expansion of public infrastructure. Consequently, the construction of public buildings, including libraries, increased, supported in part by EU funding for cultural infrastructure development. Although there is only one direct reference to EU-funded improvements to cultural infrastructure in the Tri-City area (European Solidarity Center in Gdańsk) (Kowalski et al., 2019, p. 199), it is likely that the development of modern libraries was similarly influenced by these contributions.

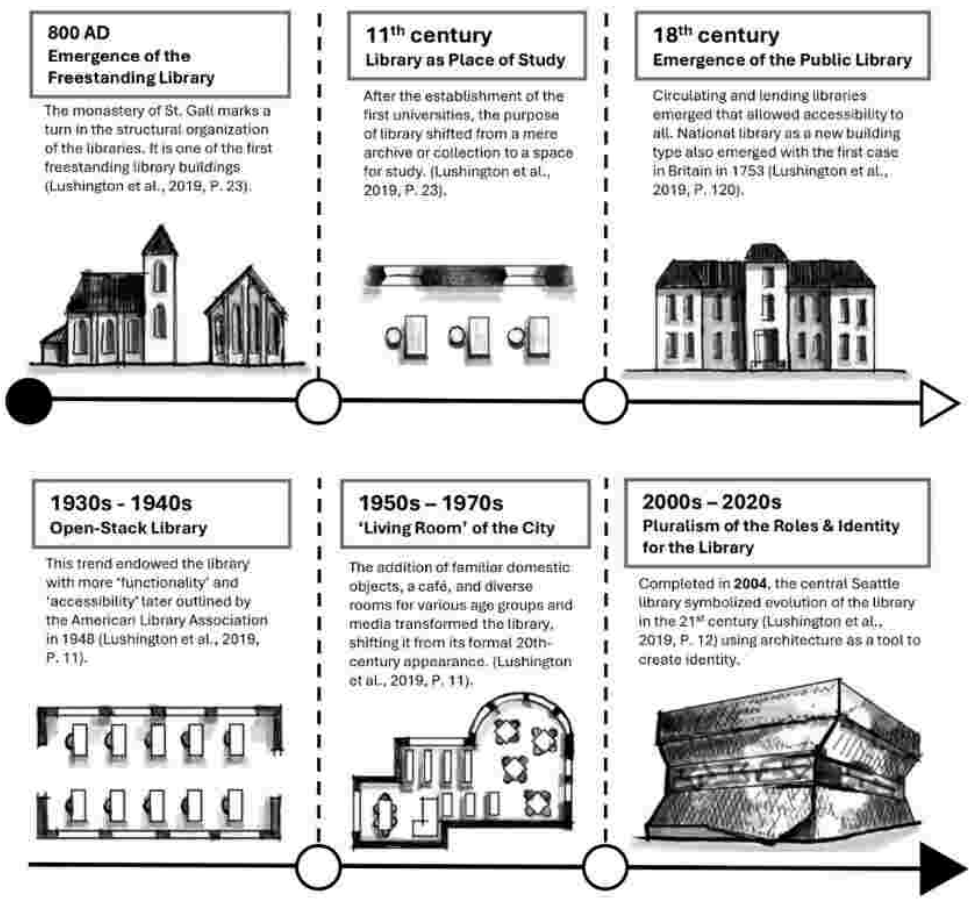


Fig 1. Timeline of library development highlighting periods where daylight and user movement could have influenced design (source: author).

III. Problem Statement

The purpose of this study is to explore the relationship between daylighting conditions and user behavior (including movement as a component) in library interiors. Daylight is a critical aspect of architectural design, impacting the visual and physiological comfort of occupants, sustainability, human well-being within built environments., and overall building performance. However, the existing knowledge in this area often lacks a comprehensive understanding of how daylight interacts with movement patterns within buildings. This knowledge gap presents a compelling research problem.

Despite extensive research on daylighting in architecture, there is still limited understanding of how daylight influences user behavior at the micro-scale of interior spaces, particularly in public libraries. Existing studies rarely integrate architectural analysis, behavioral observation, user perception, and simulation-based methods to examine how daylight conditions affect seat selection, duration of stay, movement patterns, and social observation within a single, defined interior environment. The research problem therefore lies in identifying and explaining the relationships between daylighting conditions and user movement and behavior in library spaces, while accounting for individual differences such as personality traits and behavioral preferences. The research problem of this study concerns the complex relationships between daylight, spatial configuration, and user behavior and movement in public libraries, analyzed in the context of different types of spatial layouts (open and enclosed) and varying seasonal conditions. The research focuses on two main components: the analysis of user behavior and the analysis of daylighting conditions. All other elements - such as the analysis of architectural typologies of libraries, additional observations of user behavior, and, in selected cases, the collection of photographic documentation and architectural analyzes of the buildings - serve as secondary, supporting components of the study.

IV. Scope of the Study

This study investigates the relationship between daylighting conditions, user behavior, and user movement within a contemporary, purpose-built library interior. The research is structured around three interrelated layers:

- Physical characteristics of the library space:
  The case study focuses on a contemporary, purpose-built library building that exemplifies current architectural approaches to public interior design. The analysis concentrates on the physical characteristics of the interior space, including spatial layout, organization, and architectural elements that shape user experience and influence patterns of occupation and movement. After a detailed survey, two case studies were chosen that are Maly Kack and Witomino Libraries in Gdynia.
- User behavior and movement:

User interaction with the library space is examined through two distinct yet related dimensions that are user movement (Fig. 2) and library user behavior (Fig. 3). First, user movement is examined through behavioral observation and, for spatial analysis, space syntax techniques. For the space syntax analysis, connectivity and visibility graph analysis are applied using DepthmapX. Within the observational part, user movement is seen as the dynamic presence of users in space. Movement is measured using clear, quantifiable variables, including relocation frequency between points, duration of stay at specific locations, and counts of occupancy at those specific locations. These variables are represented spatially through trajectories and stationary locations, where trajectories indicate the frequency and extent of movement, and stationary points capture the time spent and number of users at each location.

Secondly, user behavior addresses patterns of space use, including why users visit the library, how they occupy different areas, and the activities they engage in. Behavioral patterns are identified through observation and documented in relation to spatial and environmental conditions.

- Daylighting performance:
  The study focuses exclusively on daylight entering the interior through architectural elements such as windows and skylights. Electrical lighting is deliberately excluded in order to isolate the effects of daylight alone. Daylighting conditions are evaluated using established performance indicators, including glare, horizontal illuminance, and Useful Daylight Illuminance (UDI). Daylight simulations are conducted for three representative months - December, March, and June - using AnnuOWL software.
- Tricity area:
  the Tri-City area in Poland from which the case study is selected, comprises three main Baltic cities: Gdańsk, the largest and historic center; Gdynia, a modern port city; and Sopot, a well-known seaside resort.

Based on these three layers, the study develops an integrated approach to correlating daylighting conditions with user movement and behavior within the library interior. Particular attention is given to how daylight influences spatial use and movement patterns, offering insights into the interaction between architectural design (library interior), environmental performance (daylighting condition), and human experience in contemporary public interiors (through user movement analyzes).

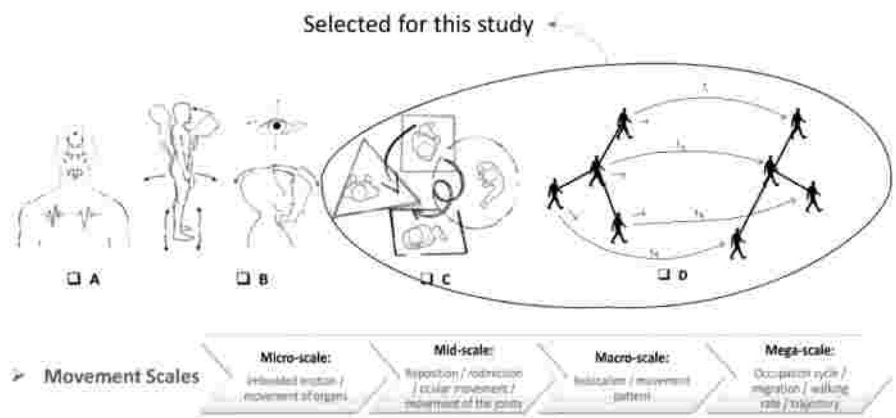


Fig 2. Schematic representation of the notion of user movement applied in this dissertation (Source: adapted from Ahmadi, 2024).

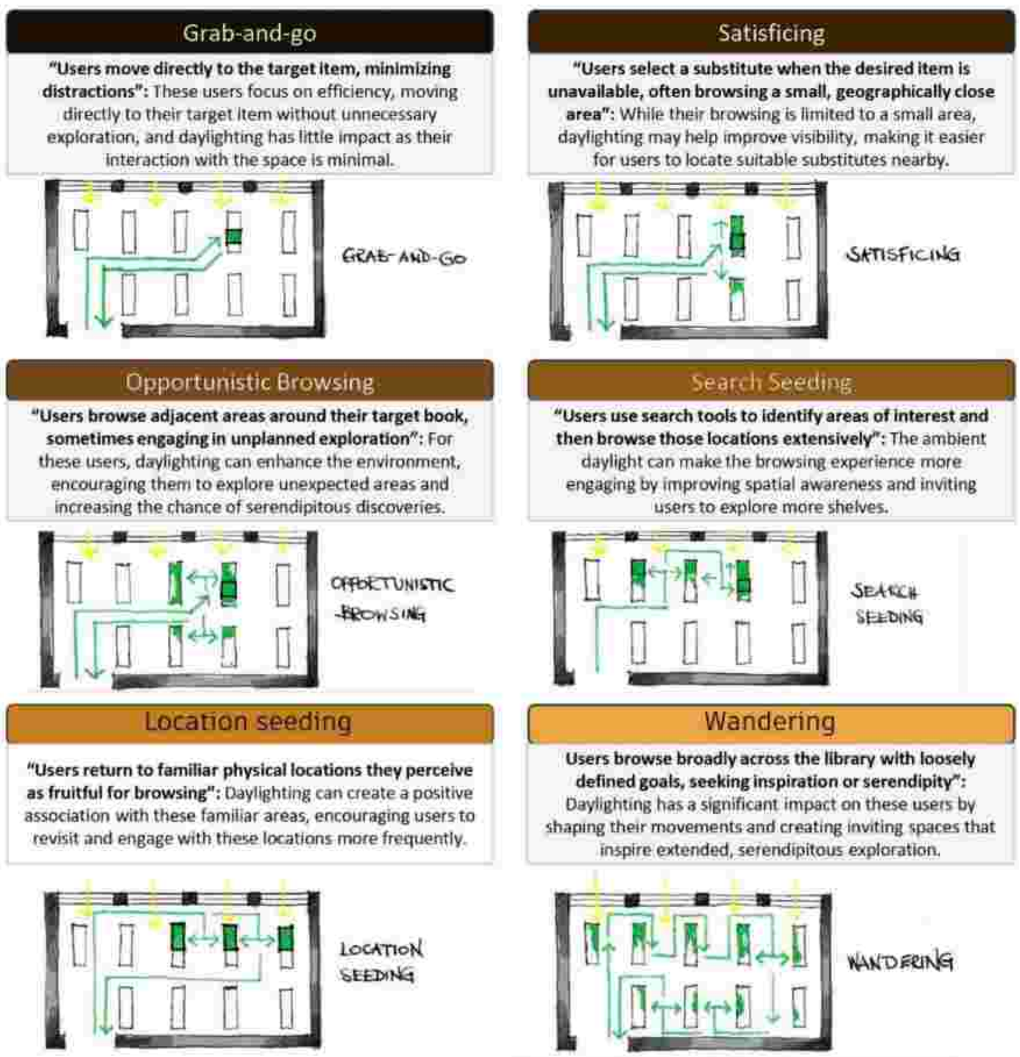


Fig 3. Schematic representation of the notion of library user behavior in this dissertation (Source: Ahmadi et al., 2026).

V. Research Objectives and Questions

Main objective

The main objective of this research is to analyze the relationships between daylight conditions and user behavior and movement in contemporary library interiors, considering spatial atmospheres, architectural layout, seasonal variation, and individual user characteristics. The study also aims to develop and apply a mixed-method framework combining parametric simulations and observational data to examine how spatial configuration, environmental quality, and human experience interact.

Specific objectives

The conceptual objective of this study is:

- To identify the way user behavior (particularly movement) is addressed in daylighting research studies.

The empirical objectives of this study are:

- To identify how spatial layout characteristics (open-plan vs. closed-plan configurations) mediate the relationship between daylight conditions and user behavior.
- To explore how different library user behavioral types influence preferences for daylight and spatial conditions.
- To investigate the relative importance of non-lighting factors (e.g., privacy, comfort, noise) compared to daylight in seating selection and duration of stay.

The comparative objectives of this study are:

- To compare the influence of daylight conditions – particularly Useful Daylight Illuminance (UDI), glare, and daylight provision - on user behavior and spatial experience in open-plan versus closed-plan library layouts, particularly in terms of movement, spatial preference, and occupancy patterns, and to examine how these relationships are mediated by spatial configuration through space syntax metrics – particularly connectivity and visibility.
- To investigate how seasonal variation (winter, spring, summer) affects the relationship between daylight conditions (UDI, glare, and daylight provision), spatial configuration, and user behavior.
- To analyze how different spatial configurations modify daylight distribution patterns and their behavioral outcomes, including spatial integration (using connectivity, and visibility measures), movement intensity, and spatial

efficiency, with specific attention to how daylight conditions (UDI, glare, and daylight provision) are mediated by open and closed plans.

Research Questions

- **RQ1:** How are user movement and behavior conceptualized in daylighting research, and how can it be operationalized for spatial performance evaluation in library interiors?
- **RQ2:** To what extent do daylight conditions influence user behavior and movement patterns in library interiors, and how is this relationship mediated by spatial layout?
- **RQ3:** How do different user behavior typologies and non-lighting environmental factors (e.g. privacy, acoustic conditions, thermal comfort) interact with daylight in shaping space use and user preferences?
- **RQ4:** How does seasonal variation affect the relationship between daylight conditions and user behavior in library interiors?

VI. Thesis Statement

Main Hypothesis

Daylighting is one of the most important factors defining the architectural form of the library as a building, however, spatial and functional configuration of contemporary libraries play a key role in how the space is used in relation to daylight. Moreover, seasonal variation significantly modifies the relationship between daylight conditions and user behavior.

Specific Hypotheses

- Daylight conditions differentially influence user movement patterns and spatial occupancy in open-plan compared to closed-plan library layouts.
- In spaces intended for focused work, non-lighting environmental factors (e.g. visual privacy, acoustic conditions, and thermal comfort) exert a stronger influence on seat selection than daylight conditions alone.

VII. Research Methodology

The structure of this thesis follows a multi-layered research approach designed to examine the complex relationships between library architecture, user behavior, and daylight (Fig 4). It begins with theoretical research through a literature review focused on two key areas:

- A review of contemporary libraries, including their evolution, functions, and current design trends, accompanied by a brief overview of libraries in the Tri-City region (refer to Chapter 1) to understand how the architectural form was shaped.

- A review of studies on library user movement and behavior in relation to daylighting, aimed at extracting definitions of user movement and the methods used to assess both user movement and daylighting conditions. In addition, apart from library user movement definitions another review identified six library user behavior types in the libraries.

This theoretical foundation informed the identification of case studies for empirical analysis and the development of the research design. In addition, a review of how movement is assessed in daylighting studies has been previously published by the author (Ahmadi, 2024). The methodology review presented here is supported by a detailed review of daylight-related studies provided in Appendix 1.

Based on the reviews this study employed direct observation (Guo et al., 2022; de Montigny et al., 2012), behavioral mapping (Kyle Konis, 2013; Dubois et al., 2009; Izmir Tunahan et al., 2022), and space syntax analysis (Saeidi er al., 2024) for assessing movement in daylighting studies, chosen for their suitability, resource availability, and alignment with the literature.

Ethical approval for the behavioral analysis of library users was obtained from the Politechnika Gdanska Research Ethics Committee (Approval No. RN 4/2025; see Appendix 2). The study involved non-intrusive observation and behavioral mapping in public library spaces, with no collection of personally identifiable information. Participation in questionnaires was voluntary, and informed consent was obtained from all respondents. Photographic documentation avoided identifiable features, and all data were anonymized and stored in accordance with institutional data protection guidelines.

Daylight assessment in buildings is crucial for sustainable design, affecting energy efficiency, occupant comfort, and well-being. Key methods in daylighting literature include daylight measurements and metrics (Pan & Du, 2022; Atzeri et al., 2016; Montaser Koohsari & Heidari, 2022; Arango-Díaz et al., 2022; Taştemir et al., 2020; Adam et al., 2016; Zhou et al., 2015), simulation techniques (Huang et al., 2022; Sepulveda-Gil et al., 2022; Kamaruzzaman et al., 2015; Chaudhary & Jain, 2014; Ámundadóttir et al., 2013; Villalba et al., 2018; Moazzeni & Ghiabaklou, 2016; Andersen, 2015), and subjective assessments via surveys and interviews (Hourani & Hammad, 2012; Izmir Tunahan et al., 2022; Rockcastle et al., 2017; Jiang et al., 2022; Ouahrani, 2012; Panahiazar & Matkan, 2018; Bournas & Dubois, 2020).

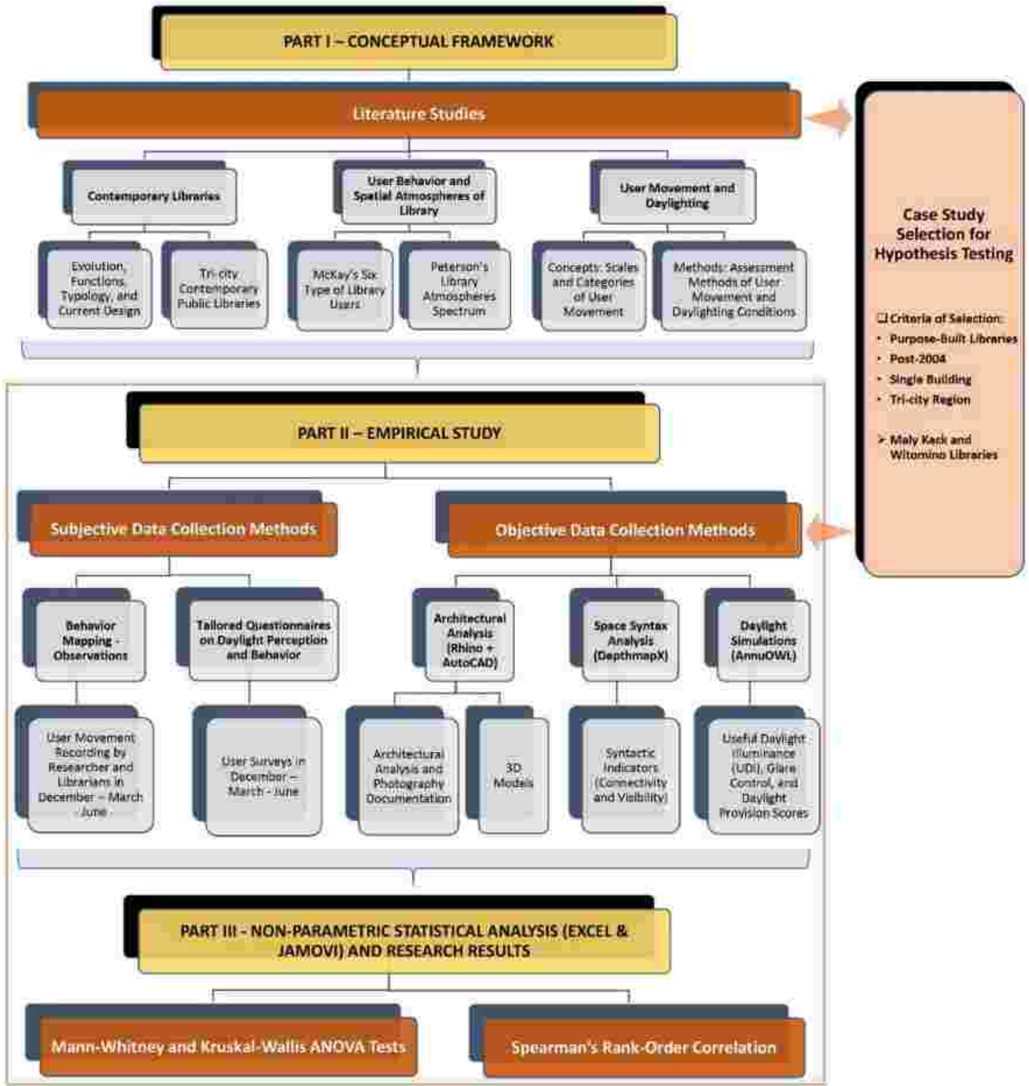


Fig 4. Research methodology workflow (source: author).

Simulations, particularly Radiance-based and Climate-Based Daylight Modeling (CBDM) tools, provide predictive insights, while in-situ measurements capture context-specific nuances, often complemented by occupant feedback at the time of the survey. Although in-situ daylight measurements using lux meter and DSLR camera were conducted, particularly during the winter period, daylight simulations were considered more reliable for the final data analysis. Due to limitations in precision, consistency, and post-processing of measurement data, only simulation results - based on accurate digital models of the buildings - were used in the final data wrangling and analysis. Recent advancements, such as the

AnnuOWL plug-in for Grasshopper, enable detailed annual and monthly daylight performance analyses using metrics like UDI, sDA, DF, and Occupant Visual and Non-Visual Illumination (OVNI) (Maskarenj et al., 2022; Maskarenj et al., 2023; Maskarenj, n.d.) (Fig. 5). Therefore, in the objective part of the daylighting data collection process, AnnuOwl software was selected for this study.

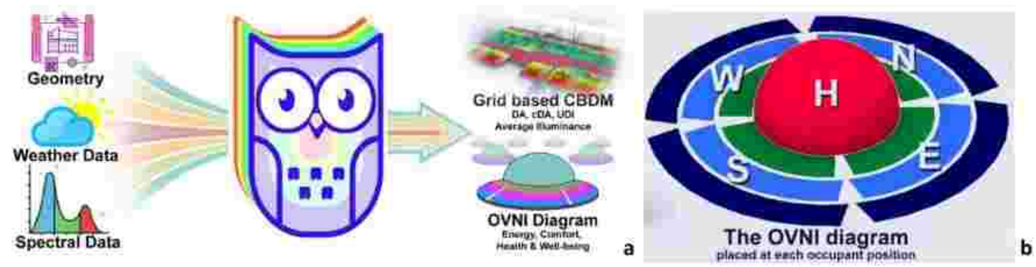


Figure 5. AnnuOWL software workflow. Data input and output (a), OVNI diagram (b) (Source: Maskarenj, n.d.).

Space Syntax is an objective method for analyzing movement patterns by modeling architectural space as a graph of interconnected units (Hillier & Hanson, 1984; Hillier, 1996). Core measures such as connectivity, depth, choice, integration, and entropy explain accessibility, centrality, and movement predictability within spatial systems (Hillier & Hanson, 1984; Hillier, 1996). To address limitations of axial analysis, Visibility Graph Analysis (VGA) was introduced to assess movement based on visual connectivity and visual integration (Turner et al., 2001), implemented through tools such as DepthmapX (Syntax Online, 2025). At the building scale, connectivity and visibility are considered behaviorally grounded parameters that together provide a comprehensive representation of user movement patterns.

Overall, this study investigates the relationship between daylighting conditions and user movement in library spaces using a mixed-methods approach grounded in pragmatism and integrating positivist and constructivist perspectives (Groat & Wang, 2013). Quantitative methods include AutoCAD 2D and Rhino 3D modeling, space syntax analysis using DepthmapX (Connectivity and Visibility Graph Analysis) (Space Syntax Online, 2025), complemented by daylighting simulations using Rhino + AnnuOWL (UDI, DP, DGP). Qualitative methods comprise direct observation, behavioral mapping, photographic documentation, and questionnaires for users and librarians, with data collected across three timelines in December, March, and June. These methods are combined in a multi-layered research design to identify correlations between spatial configuration, daylight performance, and user movement (Fig. 6).

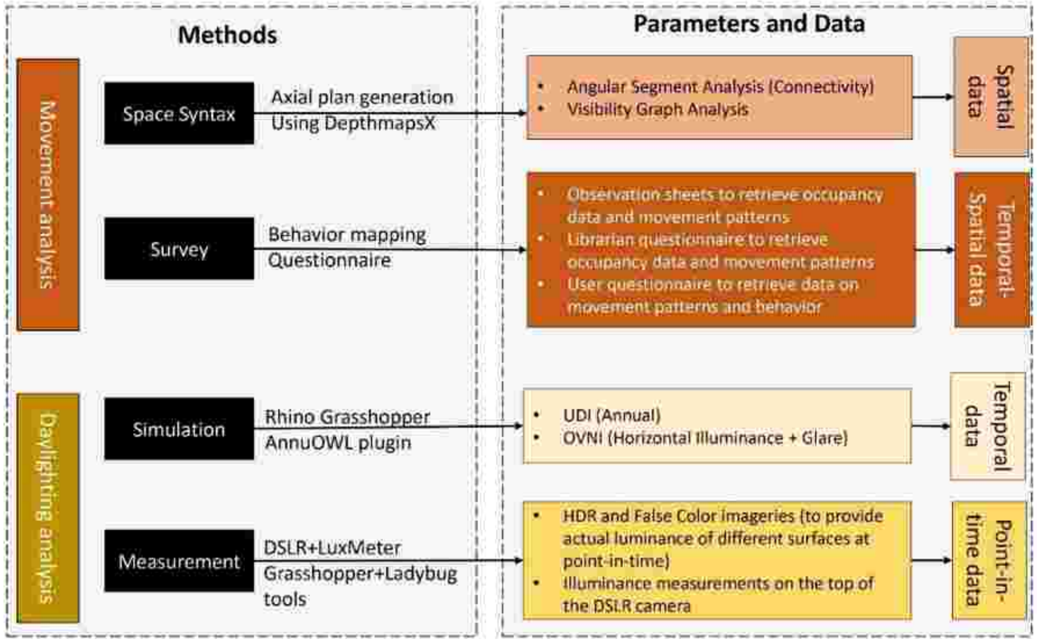


Figure 6. Diagram of the parameters of the research (Source: author).

The eleven key studies selected to inform the methodology were chosen based on their relevance to library buildings, feasibility, and methodological validity in examining the relationship between daylighting and user movement (Table 2). These studies employed behavior mapping and observation (Fig. 7) (Dubois et al., 2007; Omar et al., 2018), daylight simulations using Velux Daylight Visualizer and Rhino-based tools (Okwuosa et al., 2024; Liu et al., 2023; Dabaj et al., 2022), photography and luminance mapping (Aram & Alibaba, 2018; Jørgensen et al., 2012), questionnaires and experimental studies on seating preference and daylight perception (Jørgensen et al., 2012; Izmir Tunahan et al., 2022; Kilic & Hasirci, 2011), space syntax analysis of movement patterns (Saeidi et al., 2024), monitoring and illuminance measurements (Omar et al., 2018), and comparative case studies of library design (Edwards, 2011).

Table 2. References of the methods intended to be used in the research and have been previously tested (Source: author).

Parameters under investigation		**Nature of the data**	**Methods or techniques of data collection**	**Output values**	**Research example**
Behavior (Movement)	• Spatial accessibility • movement paths • layout connectivity	Interval quantitative data	Rhino 2D modleing + DepthmapsX Space syntax	Axial maps of Connectivity , Spatial Choice, Integration,	Both et al. (2013), Saeidi et al. (2024)

	• distance from key points • movement pattern complexity			Depth, and Entropy	
	• Occupation time • Occupation count • Movement direction • Table/seat selection	Interval quantitative data, and Ordinal qualitative data	Observation Questionnaire	Description with behavior map of the library users	Dubois et al. (2007), Kilic & Hasirci (2011), Izmir Tunahan et al. (2022)
Daylighting	• Daylighting experience	Nominal qualitative data	Observation HDR photography	Descriptions with photography documentation	Edwards (2011), Aram & Alibaba (2018)
	• Daylighting perception	Ordinal Qualitative data	Questionnaire	Reports and spatial perception map	Izmir Tunahan et al. (2022), Aram & Alibaba (2018)
	• Daylighting condition	Interval quantitative data	Daylight simulation	DF, sDA, DGP, UDI maps	Dabaj et al. (2022), Liu et al, (2023)
			Daylight measurement	Point-in-time Illuminance levels map on the working plane	Arango-Díaz et al. (2022)
			False color imagery	Luminance mapping	Jørgensen et al. (2012)

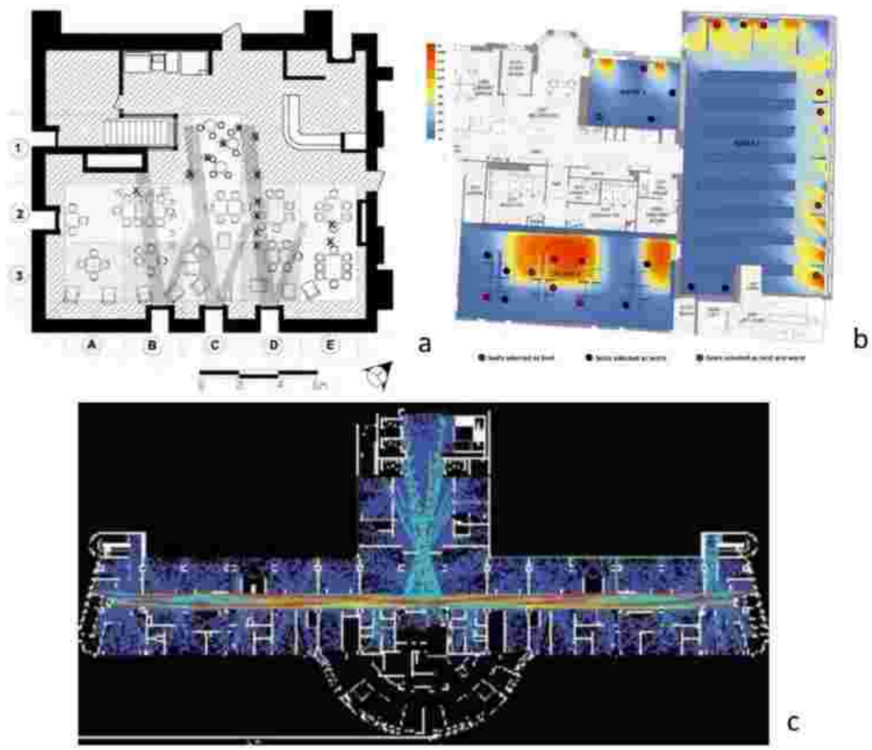


Figure 7. Three different approaches to map the behavior of users in a building based on observation (a) (source a: Dubois et al., 2007), questionnaire (b) (source b: Izmir Tunahan et al., 2022), and space syntax (e.g. choice value) (c) (source c: Saeidi et al., 2024).

VIII. State-of-the-Art

> "Ancient art represents the subject accordingly. And now: the experiences of a modern man, walking across the deck of a steamer; 1. His own movement; 2. The movement of the ship which could be in the opposite direction; 3. The direction and the speed of the current; 4. The rotation of the earth; 5. Its orbit; and 6. The orbits of the stars and satellites around it. The result: an organization of movements within the cosmos centered on the man on the steamer."
> Plummer (2016, p. 215)

A comprehensive review of user movement definition in daylighting studies in library buildings has been previously published by the author (Ahmadi et al., 2026). A part of the theoretical foundation of this dissertation builds upon that work. This review systematically analyzed peer-reviewed studies indexed in the Web of Science and Scopus databases, focusing on research addressing daylight in library environments and its relationship to user movement. The review establishes clear conceptual distinctions between user behavior and user movement, where behavior refers to underlying intentions and strategies, and movement denotes the observable spatial manifestation of library user behaviors within architectural settings. Based on a thematic synthesis of studies across multiple building types, six movement-related categories were identified, providing a structured framework for interpreting how daylight and movement interact within built environments. The movement-related categories introduced in this paper are derived from studies across multiple building types and are subsequently applied to the library context.

User Experience and Spatial Utilization define movement as user attendance and spatial exploration within the library, where daylight influences how users perceive, navigate, and engage with space (Edwards, 2011; Jørgensen et al., 2012; Liu et al., 2023; Mortazaee & Haron, 2021). Broader daylighting research shows that atriums and daylight-rich spaces enhance spatial experience, engagement, and patterns of use, implicitly addressing movement through spatial occupation, activity distribution, and exploratory behavior (Yunus et al., 2010; Hourani & Hammad, 2012; Ma & Yang, 2022). Studies on passive, biophilic, and smart building designs further highlight movement-related outcomes such as purposeful physical activity, circulation, and activity-based engagement, demonstrating how daylight and spatial layout shape exploratory and movement-driven behavior (Ouahrani, 2012; Kaiwen et al., 2016; Manurung, 2017; Maghlakelidze et al., 2024; Chen et al., 2025; Turrin et al., 2016).

Occupants' Positions and Choice of Spatial Locations category defines movement as the occupant's choice of location within the library, focusing on seat and table selection influenced by daylight (Izmir Tunahan et al., 2022; Kilic & Hasirci, 2011; Aram & Alibaba, 2018; Dabaj et al., 2022). Studies show that daylight availability, visual comfort, privacy, outdoor views, and spatial arrangements guide how users select their positions, with data collected through observation, surveys, and simulations. Beyond library settings, the Occupants' Positions and Choice of Spatial Locations category has been widely studied in urban and interior environments, where daylight influences resting, positioning, and circulation behaviors (Krüger et al., 2019; Zeibo et al., 2021; Park et al., 2015; Parise et al., 2013; Hosseini et al., 2020). Research demonstrates that occupant position selection guides visual comfort, energy optimization, glare mitigation, and lighting control through strategies such as dynamic attraction points, movable views, and blind adjustment (Pan & Du, 2022; Bian et al., 2018; Huang et al., 2022; Montaser Koohsari & Heidari, 2022; Atzeri et al., 2016). These findings highlight that daylight-responsive choice of location is a key behavioral factor shaping spatial use and environmental interaction across diverse building types.

Walking and Transition category defines movement as users' walking, presence, and transitional movement within the library, including the influence of others' movement. While Nasrollahi and Shokry (2020) address this notion objectively through simulations of a library environment that account for the presence of others, it can also be translated to real-time movement and transitions in libraries, where moving users may similarly affect daylight conditions and the experience of other occupants. Beyond library settings, the Walking and Transition category is supported by a broad body of urban and interior research linking daylight to walking behavior and transitional movement. Studies demonstrate how daylight and environmental conditions influence pedestrian routes, movement intensity, usage patterns, and shade-seeking behavior in streets and public spaces (de Montigny et al., 2012; Zacharias et al., 2001, 2004). More recent research integrates user movement with lighting comfort and daylight modeling to optimize walking environments, navigation, and spatial experience (Liu et al., 2016; Almaiyah & Elkadi, 2012; Tafahomi, 2022). Indoor-focused studies further show that daylight affects perceptual transitions, safety, sensorial experience, experiential quality, and circadian synchronization during movement, reinforcing the role of walking and transition as daylight-responsive behaviors across diverse architectural contexts (Panahiazar & Matkan, 2018; Lasagno et al., 2011; Nasybullina et al., 2019; Kristo & Kristo, 2021; Andersen et al., 2013).

Occupation Over Time category defines movement as the evolution of users' movements across the day, shaped by daylight conditions (Omar et al., 2019). Studies use occupancy monitoring and lighting simulations to optimize daylighting and support dynamic use of library spaces. In broader contexts, the Occupation Over Time category similarly examines how users' presence and activity patterns evolve throughout the day, typically in office and workplace environments (Jens & Khoudi, 2023; Hunt, 1979). Research highlights temporal occupancy, manual control behavior, and daylight usage as key factors influencing energy performance and visual comfort (Chiogna & Frattari, 2013; Guan & Yan, 2016; Moazzeni & Ghiabaklou, 2016; Kamaruzzaman et al., 2015; Lolli & Haase, 2017; Nezamdoost, Mahic, & van den Wymelenberg, 2018; Nezamdoost, van den Wymelenberg, & Mahic, 2018). These findings support the library context by showing that user movement often appears as prolonged stationary occupancy, emphasizing the importance of time-based patterns in daylight-responsive design.

Building on these theoretical distinctions, this dissertation translates the identified movement categories into a multi-layered methodological framework that combines architectural, environmental, and behavioral analyzes. In response to the limitations observed in the literature - where user movement, daylighting, and spatial configuration are often examined separately - the study integrates direct observation, behavioral mapping, questionnaires, and photographic documentation with objective analyzes using space syntax and climate-based daylight simulations. As summarized in Table 1, spatial configuration is analyzed through connectivity and visibility metrics, user movement is examined through occupation patterns, movement intensity, and seat selection, and daylight conditions are assessed through simulation-based performance metrics. The intention of adopting this multi-layered methodology is to capture user movement as both a spatial and experiential phenomenon, allowing daylight performance, library architecture, and user behavior to be examined simultaneously and across different scales. This integrative approach enables a more comprehensive understanding of how daylight and spatial configuration jointly influence movement and use patterns in contemporary library spaces, thereby addressing key methodological gaps identified in the state of the art.

A recent study by Pan et al. (2025) similarly combined space syntax and daylight simulations to examine the relationship between spatial configuration, environmental performance, and occupancy in hybrid office environments. While methodologically comparable in its integration of spatial and environmental metrics, that study relied primarily on sensor-based monitoring and predictive modeling of seat use. In contrast, the present research extends this line of inquiry to library contexts, where movement is less constrained and more closely tied to daylight perception, learning behavior, and informal use. By prioritizing subjective data alongside computational analysis, this dissertation advances a user-centered, mixed-methods framework that captures experiential and behavioral responses to daylight beyond predictive occupancy models.

IX. Identified Research Gaps

The State-of-the-Art review identified six categories that conceptualize movement as both a response to and a modifier of daylight; however, when applied to library buildings, this framework reveals a notably limited body of research. Only ten studies explicitly address user movement in relation to daylighting in the context of the library buildings, underscoring a significant research gap and reflecting the broader scarcity of architectural studies that simultaneously examine user behavior, movement, and daylighting in library spaces. Existing research primarily engages with four categories - User Experience and Spatial Utilization, Occupants' Positions and Choice of Spatial Locations, Walking and Transition, and Occupation Over Time - where movement is largely addressed indirectly through seating behavior, spatial positioning, and temporal occupation. In response to these limitations, this dissertation introduces a novel empirical methodology that systematically links user movement and daylighting in libraries, establishing a foundational framework for future research in this underexplored domain.

User movement in built spaces is influenced by multiple factors, including the dynamic impact of sunlight. Studying daylighting is important for both passive design and user-centered design. As daylighting strategies become more common, research on users' interactive roles in these spaces has gained prominence. A recent study examined movement through view-out, showing how moving objects seen through windows affect occupant engagement (Cho et al., 2023), and highlighted that existing view metrics often neglect movement. Similarly, this paper focuses on user movement in daylighting, aiming to establish clear terminology and consider factors like movement scale, level, and interaction with daylit spaces. All in all, one important research gap that this dissertation mainly tries to cover is the development of a framework that seamlessly could link daylighting condition with building user movement.

X. Thesis Structure

The thesis consists of an introductory section, four numbered chapters, and a concluding section containing the analysis of results and discussion. The overall structure of the thesis is presented in Figure 8 below.

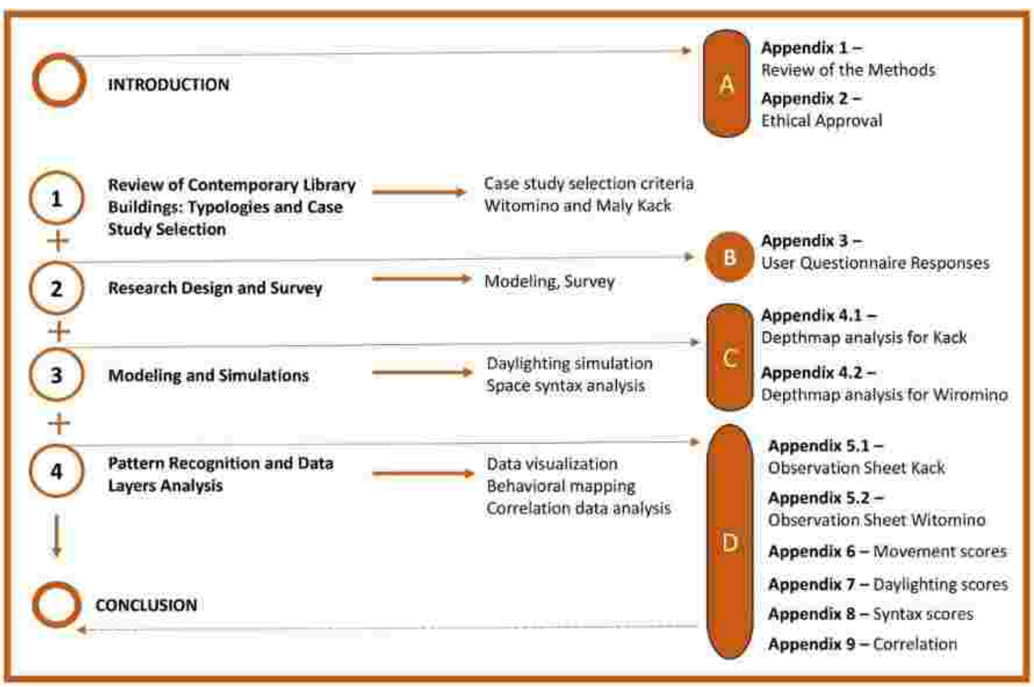


Figure 8. The outline of the Dissertation (source: author).

XI. Glossary of the Terms

Daylighting Conditions

The quality, quantity, and distribution of natural light within the indoor space, influenced by factors such as time of day, season, and architectural design. In this research it is measured using diagrams like Occupant-centered Visual and Non-visual Illumination (OVNI), Useful Daylight Illuminance (UDI) Compliance, Glare Control, and Daylight Sufficiency (Maskarenj et al., 2023).

User Behavior

The patterns of human activity, including desires, motivations, and feelings, that both shape and are shaped by the built environment (Rapoport, 1969, P. 16). McKay et al. (2019) identifies six type of user browsing behaviors in libraries (Table 1). For the purpose of this study, the definitions have been modified to reflect spatial zones architecturally, while preserving the essence of the original behaviors.

Table 1. Library user behavior types (source: adapted from McKay et al. 2019).

Original Type	Generalized Architectural Definition
Grab-and-go	Moving directly through the library to achieve a specific goal, minimizing interaction with space and surroundings.
Satisficing	Navigating a limited area of the library, adjusting to spatial or material constraints to meet immediate needs.
Opportunism	Responding to unexpected spatial cues, allowing unplanned interactions with the environment to shape the experience.
Seeding by Search	Using prior information or guidance to enter a productive area, then actively engaging with the surrounding space.
Seeded by Location	Returning to familiar, productive zones to efficiently explore and interact with the space.
Wandering	Roaming freely, using the spatial layout to discover and interact with unexpected elements in the library.

User Movement

Under the umbrella of user behavior, user movement refers to the physical trajectories and spatial transitions of users within the library, recorded through behavior mapping, observation, or tracking techniques. In this study, user movement is interpreted through four dimensions identified in the state-of-the-art review: spatial utilization, place preferences, movement trajectories and transitions, and temporal patterns of space use.

Within this framework, two research-defined indicators Movement Intensity, and Spatial Efficacy are introduced.

Movement Intensity (MI) is a research-defined indicator representing the frequency of user relocations to a specific spatial point within the library. It is derived from observational data and calculated as the number of user arrivals or movements recorded at each selected spatial location during defined time intervals. MI captures spatial activity concentration and movement dynamics across the plan.

Spatial Efficacy (SE) is a research-defined composite indicator measuring the effectiveness of spatial locations in supporting sustained user presence and engagement. It is based on observed average occupancy counts and average time spent at each spatial point. The indicator is further processed through logarithmic transformation and normalization procedures, as detailed in the methodology chapter, to produce a relative efficacy scale.

Spatial Atmospheres

In this study, spatial atmosphere refers to the overall sensory and social character of a library environment as experienced by its users. Following Peterson (2023), libraries are understood as spaces shaped by light, sound, materials, smells, spatial organization, and everyday human activity. Atmospheres are not fixed or neutral; they emerge through the interaction between architectural elements and user behavior, often overlapping and changing over time. These atmospheres can generate feelings of comfort, calm, welcome, liveliness, inclusion, or even tension.

Based on the recurring qualities identified by Peterson (2023), this research defines four dominant spatial atmospheres in contemporary libraries: concentration, communication, relaxation, and exploration. Concentration refers to quiet, focused environments that support individual study. Communication describes open and socially active settings that encourage interaction. Relaxation denotes warm and welcoming areas where users can feel comfortable and at ease. Exploration characterizes stimulating and sometimes complex environments that invite movement, discovery, and adaptation. These four atmospheres form the analytical framework through which the architectural qualities of daylight and movement are examined in this study.

XII. List of Abbreviations

The following abbreviations are used throughout the study. While some are derived and adapted from established metrics (including UDI, Glare, Daylight Provision, Visibility, Connectivity), others (including Spatial Efficacy, and Movement Intensity) are defined within the scope of this research.

- **CON:** connectivity
- **VIS:** visibility
- **GSC-D:** glare (sensitive) control in December
- **GSC-M:** glare (sensitive) control in March
- **GSC-J:** glare (sensitive) control in June
- **GCA-D:** glare control average in December
- **GCA-M:** glare control average in March
- **GCA-J:** glare control average in June
- **UDI-D:** useful daylight illuminance in December
- **UDI-M:** useful daylight illuminance in March
- **UDI-J:** useful daylight illuminance in June
- **DP-D:** daylight provision in December
- **DP-M:** daylight provision in March
- **DP-J:** daylight provision in June
- **MI-D:** movement intensity in December
- **MI-M:** movement intensity in March
- **MI-J:** movement intensity in June
- **SE-D:** spatial efficacy in December
- **SE-M:** spatial efficacy in March
- **SE-J:** spatial efficacy in June

Chapter One

Review of Contemporary Library Buildings: Typologies and Case Study Selection

> *"Architecture is the masterly, correct and magnificent play of masses brought together in light. Our eyes are made to see forms in light; light and shade reveal these forms."* Le Corbusier (1931)

In the Introduction, key conceptual foundations were explained by examining how user movement is addressed within daylighting studies, with particular attention to library buildings. This chapter builds on that groundwork by exploring library buildings in greater depth - considering their role in shaping user experience and how daylighting influences their spatial and functional development. The chapter culminates in the selection of a case study that will serve as the basis for the experimental investigations in the following chapters.

This chapter performs three main functions:

- Establishing the theoretical background of contemporary library design,
- Identifying contemporary library trends following 2004, and
- Applying these trends to real buildings in the Tri-City area by defining criteria for selecting case studies.

Library has been defined in different resources. The concept of a library has been referenced throughout history, from the Middle Ages to ancient times, to describe "an entire building, a room, or simply just a cupboard for storing books" (Lushington et al., 2019, P. 22).

An exact and inclusive definition of library could be:

> "a library is a collection of resources in a variety of formats that is organized by librarians to provide user access – in terms of physical, bibliographic, intellectual, and digital – that offers targeted services and programs with a mission ranging from education, informing, or entertaining, and the goal of stimulation of the learning and advancement of the individuals and the society" (Eberhart, 2010, P.1).

A library is a dynamic and evolving institution that has served as a cornerstone of knowledge dissemination and community engagement for centuries, undergoing significant transformations in its role, design, and function over time. The architecture of libraries evolved from traditional, enclosed spaces to modernist designs characterized by openness, fluidity, and ample daylighting, reflecting a shift towards accommodating diverse user needs and promoting social interaction.

Throughout the 20th and 21st centuries, libraries have continued to adapt to changing technological landscapes and societal expectations. They have transcended their traditional roles as repositories of information to become vibrant urban destinations, interactive hubs, and adaptable community centers. Embracing principles of variability, accessibility, interactivity, adaptability, and rewarding experiences, libraries offer flexible spaces that cater to a wide range of activities, from learning and research to social gatherings and entertainment. Moreover, libraries have become symbols of education, democracy, and community investment, embodying pluralism of roles and serving as monuments of progress and inclusivity.

In essence, a library represents more than a physical space filled with books; it is a dynamic ecosystem that facilitates intellectual growth, social interaction, and cultural exchange, embodying the evolving needs and aspirations of society. As libraries continue to evolve in response to technological advancements and changing user demographics, they remain indispensable pillars of knowledge, learning, and community enrichment.

Libraries are sometimes compared to ‘cathedrals’, ‘shopping malls’, or ‘casino’ because they have this duty to invite people to come in, move around, and motivate them to return. This inviting nature of libraries is further enhanced by architectural elements, such as the use of light, which can draw people in and guide their movement. This idea is reflected in places that “physically connect with light and recall pedestrian movement in a shopping mall” (Fig. 1.1). Each of these spaces - cathedrals, stores, and libraries - possesses distinct characteristics that shape the unique patterns of movement and interaction within them. In libraries, this takes the form of four stages: scanning, selecting, borrowing/purchasing, and reading materials (Lushington et al., 2019, pp. 18, 100, 145, 167) during the browsing experience. Building on this understanding, McKay et al. (2019) further articulate library use through six distinct browsing behaviors, which range from direct, goal-oriented movement to open-ended exploration. These behavior types provide a more nuanced framework for understanding how architectural space influences users’ movement, decision-making, and engagement within the library.

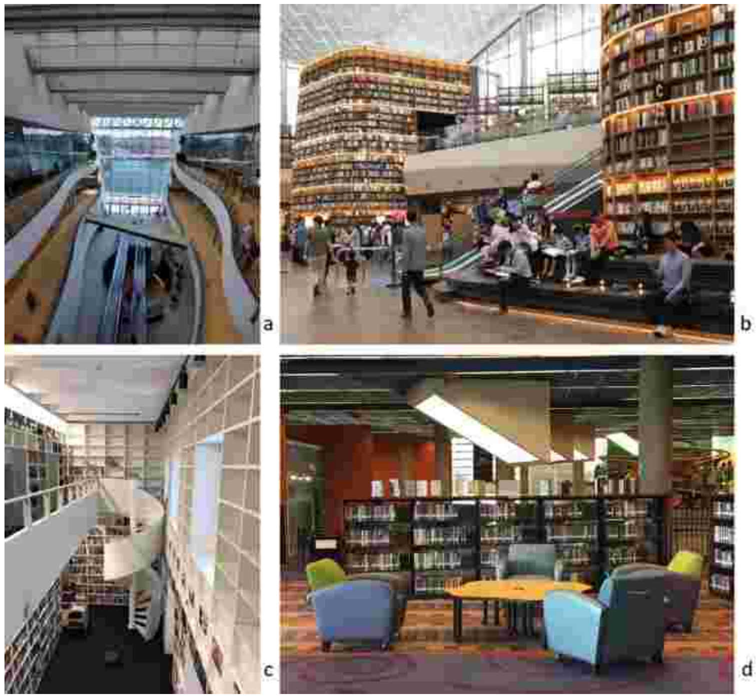


Figure 1.1. Det Kongelige Bibliotek in Copenhagen by Schmidt Hammer Lassen Architects (a). Starfield Library, Seoul by Gensler (b). Library of the Krzysztof Kieślowski Film School in Katowice by firma BAAS Architecture & Design (c). ImaginOn: The Joe & Joan Martin Center in Charlotte by Gantt Huberman Architects and Holzman Moss Bottino Architecture (d) (Images are taken by Justyna Martyniuk-Peczek and Mosleh Ahmadi)

1.1. Daylight and Movement in the Architectural Definition of Libraries

The relationship of library with both daylight and movement has been addressed specifically in the works of Henning Larsen. He as the architect of Gentofte Library explains that "daylight has always interested him more than walls and floors and the like, because daylight is what controls how people move through spaces" (Jørgensen et al., 2012). This library completed in 1985 is famous for the intuitive use of daylight in architecture, too. Moreover, Alvar Aalto is also another architect that has used daylight and movement as the parameters of shaping the library experience – such as Viipuri and Mt. Angel. In other words, he is famous in using daylighting strategies or 'hierarchy of light' to direct or 'denote movement from one place to the other or punctuate activities.' For example, in one of his works, in the Mount Angel Abbey Library, the 'conical skylights are used to direct movement and provide emphasis' (Cartwright, 2013). In this view, daylight transcends mere physical elements like walls and floors, holding the power to shape human interaction within spaces. This perspective underscores the crucial role played by natural light in influencing the dynamics of spatial navigation and user experience. By prioritizing the integration of daylight into designs, the architect not only illuminates physical environments but also orchestrates a symphony of movement and interaction, where the interplay between light and space becomes a catalyst for enriching human engagement and experience.

In the workplaces, freedom of the user movement and adjustment of the user location and posture according to the lighting condition is important. It is because the state of comfort stems from the harmony between the environment and pleasant human psychophysiological condition (Kilic & Hasici, 2011). According to Kilic & Hasici's (2011) research on the seat selection in a library, "privacy, personal space, territoriality, and crowding are four of the most influential factors that relate daylight to behavior".

It is important to note that, the new concepts of design in modernist approach for library design to enhance sustainability were 'social harmony' and 'increased levels of daylight' (Edwards, 2011). However, there is a paradox that arises from the relationship of library, daylight, and movement. While daylight is useful for the user (and the movement of the users) it might be destructive for the library (more specifically, the books) (Lushington et al., 2019, P. 43). Therefore, a library is a space where the integration of natural light shapes movement and interaction, but it faces a paradox as daylight's benefits conflict with its potential harm to materials and comfort.

1.2. Timeline and Trends of the Library Development

In ancient times, libraries served the elite, functioning more like treasuries with restricted access. A significant shift occurred in 800 AD with the establishment of the freestanding Abbey Library of St. Gall, the oldest library in Switzerland (Erne, 2010). This marked a new architectural autonomy, setting a precedent in library organization.

The 18th century brought another transformation: the emergence of the public library. France's revolutionary decree of 1789 led to the creation of 'French Municipal Libraries' (McIntosh, 1995, p. 1). Britain followed with its first national library in 1753 (Lushington et al., 2019, p. 120).

By the late 19th and early 20th centuries, the 'free library' typology emerged, emphasizing public accessibility and increasing the need for daylighting (Prizeman, 2008). This period also saw the development of the 'Tripartite library,' with progressive designs by Leopoldo della Santa (1816), Karl-Friedrich (1835), and Henri Labrouste (1868) (Lushington et al., 2019, pp. 31–32). Atrium lighting appeared in the George Peabody Library (1878), creating uniform daylight (Dubois et al., 2019, p. 60).

The 20th century introduced the ‘modular library’ (McDonald, 1933). At the same time, the 1984 City Library in Gütersloh marked the rise of contemporary European library interiors (Lushington et al., 2019, p. 97). Meanwhile, the idea of the library as a ‘living room of the city’ emerged in Scandinavia (Henley, 2024), shifting the focus toward communal spaces. For instance, Roth (2014, p. 161), describing the Seinajoki Library (1965), highlights how the library became a place for gathering, working, and simply being near knowledge.

The integration of IT increased access to digital resources and user movement, enhancing communication and interaction (Vijayakumar & Vijayan, 2011). Korea’s National Digital Library, established in 2002, offers 3D walls, touchscreens, and VR experiences (Lee, 2002; Choi, 2021). Internet-driven changes in the 1990s transformed spatial configurations: card catalogs were replaced with computers, altering adjacency requirements (Lushington et al., 2019, pp. 11, 49). By 2006, the Miriam Matthews Hyde Park Library saw tripled book circulation due to increased computer stations (Lushington et al., 2019, p. 189). New lighting demands also arose with screen use (Scherer, 1999). It is noteworthy that, library users in the digital era spend more time in libraries accessing digital resources, studying, and collaborating, which has prompted the redesign of spaces to include Wi-Fi, laptop stations, quiet zones, and flexible seating to support longer visits and varied activities (Panigrahi, 2021). Moreover, digitalized libraries increasingly incorporate technology-enhanced, multipurpose spaces to accommodate both digital access and social interaction, reflecting a broader shift from traditional, book-focused layouts to dynamic environments that support collaborative learning and evolving user needs (Meena, 2023).

A conceptual shift from ‘architecture for books’ to ‘architecture for users’ occurred in the late 20th century. Circulation areas, once isolated, began integrating with reading spaces. In the Robertson Branch Library (1997), the circulation core served as a “sunlight container” aiding orientation (Crosbie, 2006, p. 120).

The 2000s–2020s saw pluralism in library roles. The Seattle Central Library (2004) exemplified this evolution (Lushington et al., 2019, p. 12). McDonald (2006) listed key design principles: variability, accessibility, flexibility, adaptability, and interactivity - all linked to user movement. Edwards (2011) noted that 21st-century libraries, especially in Scandinavia, echo modernist ideals: prioritizing daylighting, social harmony, and openness. Today, libraries are not merely repositories but democratic, daylit spaces where ideas are exchanged.

These trends show that over time, libraries have continuously evolved, adapting to changing societal roles, current trends and styles in architecture, and user needs (Fig 1). As a result, both daylight and the movement of people within library spaces have grown in significance, directly influencing how users interact with their environment. Moreover, the of the user in the built space is affected by multiple variables and stimuli that shape their spatial experience. Among these factors, one significant variable is the dynamic impact of sunlight within the built space.

1.2.1. Post 2004 Iconic Library Designs

The year 2004 in the evolution of the 21st century's library, symbolizes a shift in the design of the libraires to be identified as different types according to the multiplicity of the roles. In other words, the Seattle Central Library, completed in 2004, sets the standard for the library of the twenty-first century not only through its visualization of change, but also through the duality of experience it offers users by accommodating two contradictory atmospheres: concentration and communication (Lushington et al., 2019, PP. 12, and 154).

In the context of the case studies in this thesis, this year is also important because 2004 is the year in which Poland was ascended to the European Union creating an opportunity for more internationalization. There has been a great deal of EU funds contribution to the development of the cultural infrastructure in Poland. Although there is only one direct mention to the improvement of the cultural infrastructure based on EU funds (European Solidarity Center in Gdansk) in the tri-city (Kowalski et al., 2019, p. 199), the development of other projects such as the modern libraries could have been impacted by such contribution.

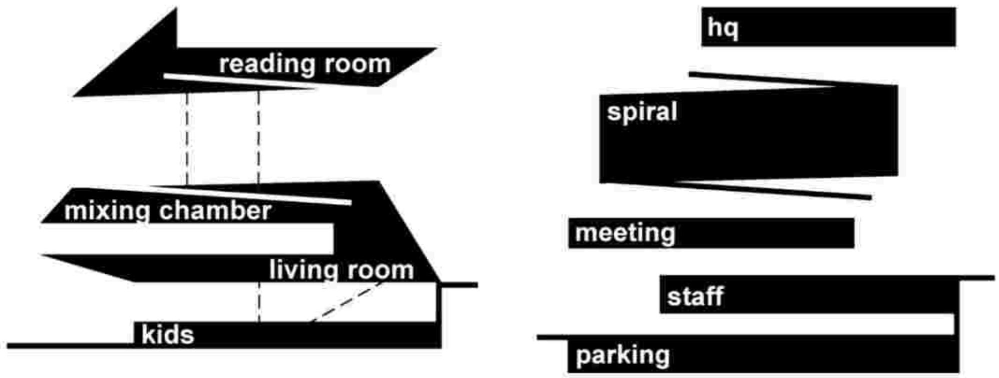
The space of a library in historical notion is perceived as "book-lined walls" to underpin the concept of book defining the architecture. However, in the contemporary notion, the book-lined walls are no longer the defining elements of the space. This fact led to the creation of the large open spaces that enjoy a free access to the space through a variety of furniture (Crosbie, 2006, P. 7). In other words, "the library has become transformed from a quiet, introverted building into an information provider for the promotion of the communication" (Roth, 2010, P. 6). Contemporary public libraries, such as Oodi and Maunula in Helsinki, use flexible, open, and transparent spaces to encourage diverse social interactions, blending work, leisure, and civic engagement within the library environment, which aligns with the trend of libraries moving beyond book-lined walls to multifunctional communal spaces (Mady & Hewidy, 2024). Moreover, not only in Scandinavia but also in Australia, recent analyzes of newly built public libraries show that designers prioritize flexibility, openness, and impactful architecture to support a range of community activities, emphasizing libraries as community hubs with open plan layouts and spaces that can adapt to changing user needs (Wakeling et al., 2025).

Below are examples of iconic libraries completed after 2004 - starting from the Seattle Central Library - that exemplify specific strategies or innovations in library design, resulting in distinct or more than usual daylighting conditions and movement patterns in the library setting. These libraries have been selected to be reviewed since they have not only manifested insights for the study of movement and daylight in the libraries, but also, they have been addressed as the 'Masterpieces' of the library architecture. The reviewed cases are mainly from three books on the architecture of libraries (Roth 2010; Roth 2015; Lushington et al., 2019).

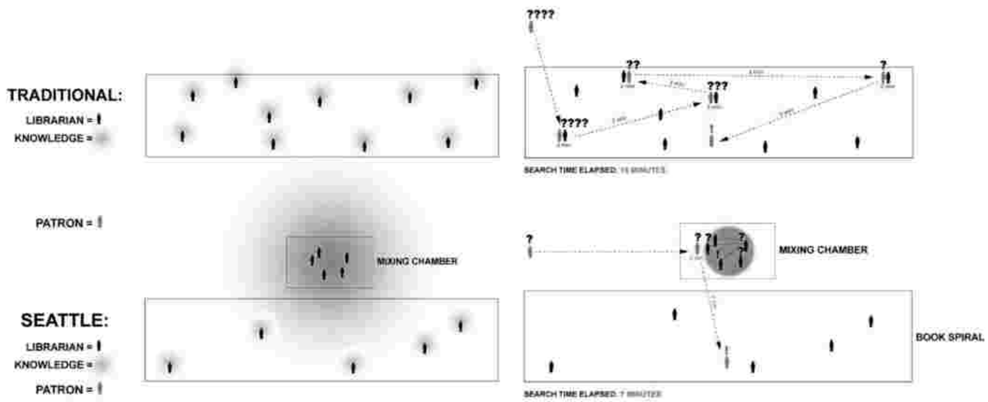
Symbol of Change

While some modern libraries, like the Jacob-und-Wilhelm-Grimm-Zentrum (built in 2009), return to formal, monumental interiors, informal seating has gained prominence through the "community living room" concept. The Seattle Central Library (built in 2004) exemplifies this shift, using informal layouts and seating to promote hospitality and interaction. Features like carrels with low dividers support semi-privacy while encouraging socialization and movement. Similarly, varied shelving bay lengths create a more relaxed, living room-like atmosphere. The library's structure comprises three stacked programmatic zones - Assembly, Multistory Book Spiral, and Headquarter - encased in a transparent exoskeleton that filters light and shadow. The Book Spiral embodies a new model of circulation, shifting from rigid floor organization to a fluid, sequential spatial experience. These "trading floors" allow users to work, interact, and explore vertically (Lushington et al., 2019, pp. 52-55, 78, 105, 145, and 155).

Ultimately, the typology of the contemporary library is shaped by its interior design, aligning with Sullivan's principle that "form follows function" (Lushington et al., 2019, p. 22). Libraries like Seattle's redefine their role - not just as repositories, but as dynamic, inclusive environments blending tradition and innovation to support both solitary study and social engagement (Fig. 1.2). In a research paper about wayfinding (Kuliga et al., 2019), researchers used the Seattle Central Library as a case study to demonstrate how its unique design features - such as shifted floor plates, open atrium, and varying visual connections - both facilitated orientation by offering clear sightlines across levels and challenged navigation due to its complex spatial layering and unconventional floor plan.



Source: https://www.archdaily.com/11651/seattle-central-library-oma-lmn



Source: https://www.archdaily.com/11651/seattle-central-library-oma-lmn

Figure 1.2. The schematic arrangement of the different functions shaping the form of the building in different floors as opposed to the traditional single floor arrangement of the functions (upper image) (Source: ArchDaily, 2009). The function of the mixing chamber (bottom image) (Source: ArchDaily, 2009).

Vertical Progression

The OBA Public Library in Amsterdam (built in 2007 by Jo Coenen) emphasizes vertical movement through a structured sequence of atmospheres: "speed/haste" at the entry level, "rest" with book stacks and seating pods around a central atrium, and "meet/relax/interact" on the upper floors for social and entertainment functions. This spatial progression enhances daylighting, user orientation, and engagement (Lushington et al., 2019, pp. 158–163). Like Seattle Central Library, OBA prioritizes vertical experience, guiding users from function to interaction while integrating light and space to support dynamic library use.

Circumferential Loop

Vertical movement is emphasized in the Stuttgart City Library (built in 2011 by Eun Young Yi) through an "inner circumferential loop" created by spiral staircases within a bright, cubic core. Daylight enters from a large central skylight above the stepped, ziggurat-like atrium and through a double façade that filters glare and maintains thermal comfort, creating an atmosphere of calm concentration (Lushington et al., 2019, pp. 164–165) (upper drawing in Fig. 1.3). In contrast, the Book Mountain in Spijkenisse (built in 2012, by MVRDV) invites users into a reading climb via terraced stairs under a transparent, pyramid-like shell (bottom drawing in Fig. 1.3). Though differing in form and lighting strategies - filtered light and quiet introspection in Stuttgart versus open, sunlit terraces in Spijkenisse - both libraries use internal loops and vertical circulation to integrate movement and daylight into a dynamic spatial experience. Van Acker et al. (2014) explain about Book Mountain that such vertical arrangements not only organize physical movement but also manifest conceptual hierarchies of knowledge, turning the act of ascending or descending through the library into a metaphorical journey that reflects the structuring and accessibility of information.

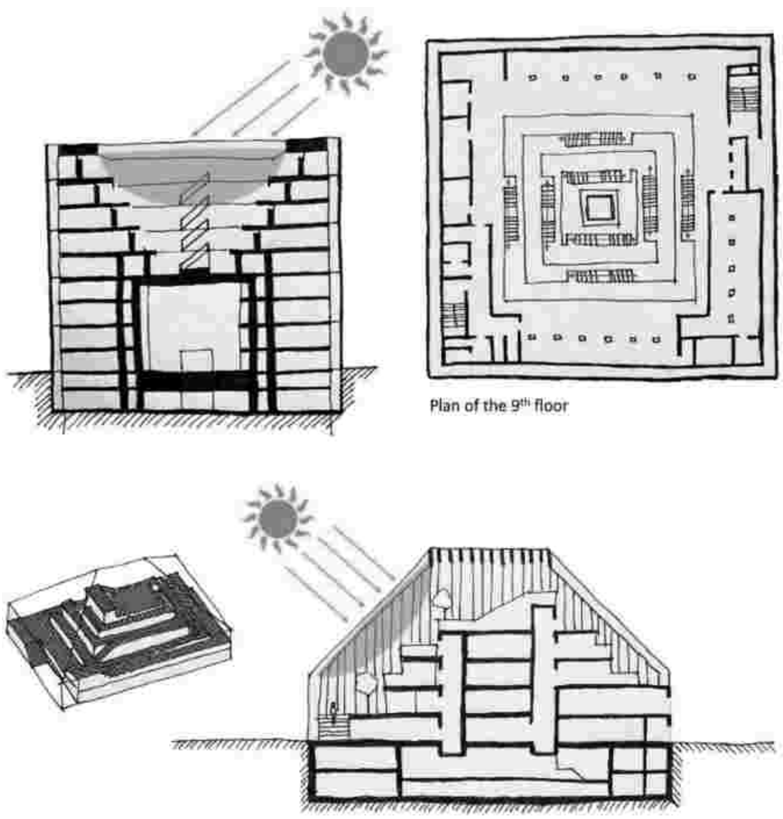


Figure 1.3. Reversed Ziggurat form of Stuttgart City Library flows the movement of the patrons down and up through the 'inner circumferential loop' (upper image). Ziggurat form of the book mountain provides an adventure like trekking through the books while the Pyramid transparent shell provides outdoor connectivity to enhance the 'outer circumferential loop' (bottom image) (source: author).

Harmony of Formality, Unidirectionality, and Transparency

The Philological Library in Berlin (Foster + Partners, built in 2005) blends filtering and transparency through a double-shell system: an outer aluminum structure and an inner translucent fiberglass membrane that creates an "atmosphere of concentration." Scattered glazed openings provide framed views of the sky or surroundings, balancing enclosure and openness (Roth, 2010, p. 113). Bookshelves are centered on each floor, while seating follows the serpentine floor edges to guide both movement and posture (Lushington et al., 2019, p. 227).

The Jacob-und-Wilhelm-Grimm-Zentrum, in contrast, reinforces formality and unidirectionality through aligned seating and a strict daylighting logic. However, "reader terraces" introduce inviting zones of relaxation, producing a balanced atmosphere (Lushington et al., 2019, pp. 232–237; Roth, 2010, p. 6). Lehmann (2023) explains that the Jacob and Wilhelm Grimm Zentrum contradicts older reading room designs, which featured large, single, tranquil halls with carefully placed columns and arches to create a serene, open atmosphere reminiscent of a grove or forest. It replaced this continuous space with a multi-level, stepped "reader terrace" organized on a strict rectangular grid, prioritizing formal hierarchy and internal segmentation over the flowing openness of historic libraries (Lehmann, 2023).

The Joe and Rika Mansueto Library (built in 2011) employs a fully transparent elliptical shell made of fritted glass to control light and provide visual connection to the exterior—balancing the rigid, unidirectional interior layout with openness (Lushington et al., 2019, p. 246). Together, these libraries demonstrate how transparency, unidirectionality, and formality can be harmonized to support focused study while offering visual relief, movement, and moments of interaction.

Eccentric Placement in Plan and Exterior Dynamics

In the Library of Birmingham (built in 2013), a deconstructivism approach is evident in the eccentric placement of circular stair openings across floors. These unaligned rotundas, paired with escalators, evoke a fluid movement reminiscent of shopping malls and provide both visual connection and daylight (Lushington et al., 2019, pp. 166–171). However, soundscape research on the building indicates that this visually open and fluid spatial organization contributes to acoustic discomfort, as the large open-plan layout and central atrium allow noise to propagate between different functional zones, undermining spaces intended for quiet reading and concentration (Aletta et al., 2016). In addition, such eccentricity in plan - featuring "jarring shapes" - can also hinder navigation, as seen in Gehry's Lewis Library (2008), where undefined forms complicate spatial orientation. In contrast, Mario Botta's work, like the Kai Feng Humanities and Social Sciences Library (2011), favors pure geometric forms to support intuitive wayfinding (Lushington et al., 2019, pp. 231, and 249). Similarly, the Vancouver Central Public Library (built in 1995 by Safdie and Associates) integrates pedestrian flow via a street-facing skylit piazza, blending interior and exterior movement while inviting urban life into the building (Crosbie, 2006, p. 158).

A comparable strategy of dynamic spatial experience is found in IKMZ (Informations-, Kommunikations- und Medienzentrum, built in 2004, by Herzog & de Meuron). It incorporates a public passage that cuts through the building and emphasizes motion through its curvilinear interior, devoid of acute angles - except at its cylindrical stair junctions. Wayfinding is enhanced by a color-coded interior, while daylight enters via a double-skin translucent glass façade (Lushington et al., 2019, pp. 222–225) (Fig. 1.4). As Herzog describes, the IKMZ's "amoeba-like" form follows a "purposeful configuration of many different flows of movement," where curvilinear geometry, color, and light work together to choreograph circulation and reinforce spatial orientation within an otherwise fluid and continuously unfolding interior (Schultz, 2020).

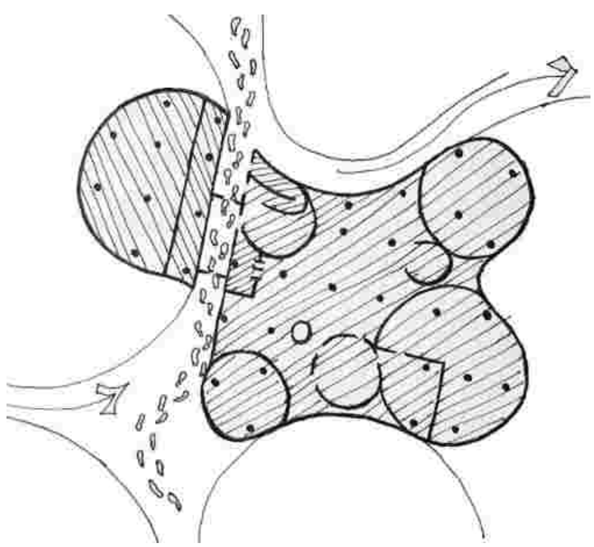


Figure 1.4. 'Interior dynamics' movement by the curvilinear placement of the walls and 'exterior dynamics' movement by the pedestrian cut-through passage (Source: Author)

The use of eccentric plans and curvilinear elements, as in the Library of Birmingham and IKMZ, creates dynamic spatial movement. While such forms can hinder navigation, as in Gehry's Lewis Library, others like Botta use pure geometry to aid orientation. These examples highlight how architectural choices influence user experience, navigation, and the library's connection to its urban surroundings.

Circulation and Architectural Cues

The intentional omission of core functions - such as the circulation desk - can foster more exploratory movement and experiential interaction. In libraries like the Arabian Public Library and ImagineOn, open plans, self-check stations, and the lack of architectural cues encourage spontaneous navigation. These design choices enhance user engagement by promoting discovery and varied spatial experiences (Lushington et al., 2019, pp. 50, 182, 191). In other words, as Kosa (2008) describes, "this structure is designed to encourage visitors to experience the joy to be found in stories of all kinds."

Openness

"A public library should evoke the idea of openness" (Roth, 2010, P. 143).

As Edwards (2011) notes, Scandinavian libraries embrace openness and fluidity, reflecting a revival of 20th-century modernist ideals prioritizing daylight and social harmony. The Helsinki Central Library (built in 2012) exemplifies this with its floating reading hall, glazed walls, and seamless integration with the surrounding plaza, encouraging movement and engagement (Roth, 2015, p. 31). Similarly, the Turku City Library uses large glazed walls to maximize limited daylight and emphasize openness (Roth, 2010, p. 143), a concept rooted in earlier Danish libraries like the Royal Library's glass bridges and illuminated lobby (Fig. 1.1a). Contrasting this openness, some libraries prioritize concentration and solitude: CINiBA (built in 2012) and Biblioteka Publica Usera Jose Hierro (2004) use narrow slits for daylighting to create a timeless, cooler atmosphere conducive to focused work, limiting inner movement (Lushington et al., 2019, pp. 124, 179, 254). Thus, while Scandinavian library design often fosters openness and interaction, it also balances spaces dedicated to quiet concentration through thoughtful daylighting strategies.

Fluidity

Fluidity as a strategy to introduce daylight and movement within library spaces is exemplified by the Rolex Learning Center, completed in 2011 (Fig. 1.5a). Compared to older library designs with a single, centralized reading room organized by columns or terraces, the Rolex Learning Center offers a "free space" and is designed as a continuous, open landscape on one level with no partitions or fixed paths. Instead of concentrating reading in one monumental space, it disperses reading and study informally throughout fluid, interconnected hills and valleys (Lehmann, 2024). Described by Lushington et al. (2019, p. 14) as a "single fluid space without boundaries," the center merges public, learning, and collection areas, blending computer interfaces with real-world instruction (Roth, 2010). The variety of seating, workspaces, bookshelves, and café areas encourage serendipitous discovery, while glass cubicles provide quiet zones, creating a spatial spectrum from introverted silence to group discussion. Architecturally, the structure mimics a landscape with fluctuating floor elevations stabilized by seven arches, fostering an experiential learning environment referred to as the "landscape of education". Users navigate the space as "travelers" on a dynamic educational journey, with daylight flooding through continuous glazed walls and fourteen circulatory patios illuminating the core (Lushington et al., 2019, pp. 79, 239, and 241; Roth, 2010) (Fig 1.5).

A precedent for this design, the Tama Art University Library in Tokyo (built in 2007), also integrates the floor with the landscape, using gently curved arched glazed walls and strategic furniture placement to balance user stillness and movement (Roth, 2010, p. 261) (Fig. 1.5b). In line with the Rolex Learning Center's principles, the Tama Art University Library similarly employs gently sloping floors, intersecting arches, and expansive glazed walls to create a fluid, continuous interior landscape that merges with the surrounding terrain, while its flexible furniture, social zones, and outdoor connections foster collaborative learning, comfort, and strong place attachment for students (Abowardah et al., 2019). The strategic placement of the seating places and bookshelves gives the place a contradictive state of user standstill and flowing of movement. As mentioned earlier, the ground floor follows the natural slope of the terrain giving an opportunity to the building to merge with the surrounding in urban contexts, similar design principles reinforce the library's role as a community hub, as seen in the Woodstock Library (built in 2000) by Thomas Hacker Architects (Crosbie, 2006, p. 84).

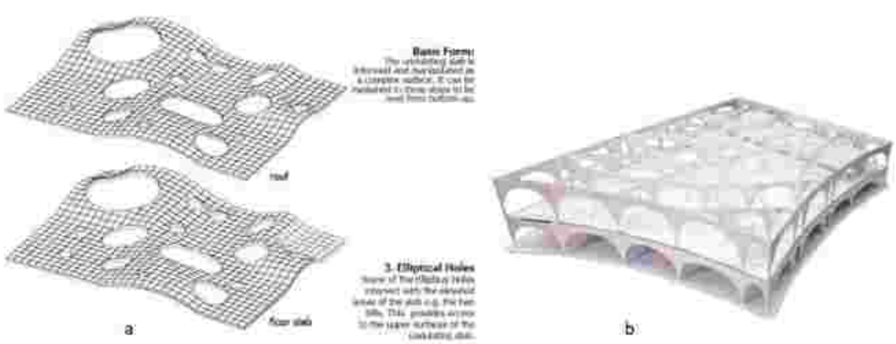


Figure 1.5. Interior techniques of showcasing the topographical architecture through showcasing the difference in elevation in different parts in the interior space of the

Rolex Center (a) (source: Jauslin, 2010), and through the ability of the chairs to tilt toward the perpendicular gravity and thus showcasing the gentle curve of the landscape in the library of the Tama art university (b) (source: Abowardah et al., 2019).

1.3. Conceptual Framework for Contemporary Library Design

Previous section (section 1.2) aimed to identify a pivotal moment in 21st-century library design evolution and assess its impact on daylighting and user movement patterns. It sought to explore the relationship between these factors and contemporary library designs by reviewing trends in library design evolution, analyzing their emergence in the 21st century, examining selected iconic library designs, and reviewing key concepts that shaped modern library design related to daylighting and movement.

All in all, Lushington et al. (2019) identify 12 significant periods in history that have shaped library design. Six of them directly could have impacted daylighting and movement patterns (Fig. 1). One notable period begins in 2004 by the emergence of the ‘Pluralism of the Roles and Identity of the Library’. This pivotal year marked by a shift in library design. According to selected cases depicted by Roth (2010, 2015) and Lushington et al. (2019), this shift was influenced by evolving roles of libraries, exemplified by Rem Koolhaas's Seattle Central Library. The design of this library embodies the concept of the 'duality of experience' that could also be observed in the design of the libraries completed later.

Building on this evolution, Lechman (2024) identifies several promising trends in library design that are likely to shape the libraries of the future, including libraries as public spaces and catalysts for urban regeneration, flexible neutral sheds adaptable to change, public pavilions within gardens, terraced vineyards, civic theaters for urban life, urban monoliths that define public context, and continuous spiral or ramped spaces offering entirely new spatial and organizational experiences.

In addition to spatial and structural innovations, user-centered design factors play a crucial role in library effectiveness. Abowardah et al. (2019) suggests that considering the five design factors, that are comfortability, collaborative environment, socialization, flexibility, and connectivity, can increase students’ attachment to the library. Each factor addresses both functional and emotional needs, such as providing comfortable seating, spaces for collaboration and social interaction, adaptable furniture, and connections to outdoor and community spaces. By integrating these aspects, the library can foster both physical and emotional attachment, ultimately enhancing students’ sense of place and satisfaction.

Table 1.1. Key design factors and features in contemporary library spaces (source: author adapted from Abowardah et al., 2019).

Design Factor	Explanation	Design Features / Attributes
Comfortability	How physically pleasant and cozy the space feels.	Moveable furniture, natural lighting, casual seating
Collaborative environment	Opportunities for teamwork and shared activities.	Round tables and group spaces
Socialization	Spaces that encourage meeting, chatting, and interaction.	Lounges, cafés, meeting areas
Flexibility	Adaptable furniture and layouts for different uses.	Variety in furniture and seating styles
Connectivity	Visual and physical links within spaces and to outdoors.	Linked indoor-outdoor spaces and integration with community

These user-centered design factors interact with spatial and environmental elements, such as daylight and movement, which form the primary focus of this thesis. In this thesis, daylight and movement are understood as closely connected elements in contemporary library design. Daylight is not only a source of illumination, but also a tool that shapes space, guides users, and highlights different activities. At the same time, user movement responds to light conditions and spatial organization, influencing how people explore, orient themselves, and use the library. Contemporary libraries are characterized by openness, flexibility, multifunctional spaces, social interaction, vertical and fluid circulation, transparency, and strong connections to the urban context. In such environments, daylight helps organize space, while movement reveals how effectively the design supports user needs. The relationship between daylight and movement therefore forms the main basis for analyzing the selected case studies in the following chapters.

Peterson (2023) describes public libraries as spaces shaped by sensory experiences, social interactions, and everyday use. Libraries are not neutral; atmospheres emerge through sound, smell, light, materials, and user behavior, often overlapping and changing, creating both comfortable and uncomfortable moments. Key qualities include comfort, calm, welcome, social interaction, liveliness, inclusion, and occasional tension. While Peterson does not propose a formal typology, these recurring qualities form the basis for this research to define four dominant library atmospheres - concentration, communication, relaxation, and exploration - as an analytical framework for architectural study (Table 1.2).

Table 1.2. Spatial atmosphere in the libraries (source: Author adapted from Peterson, 2023).

Atmospheric Qualities in Libraries Described by Peterson (2023)	Explanation	Library Atmosphere Category
Calm, muted, quiet	Calm sensory create comfort and moments of personal and shared silence.	**Concentration:** A quiet, focused area for intense study
Sharedness, sociality, communal, friendly, lively, active, vibrant	Frequent social interactions with staff and visitors make people feel included and part of a community; some areas are full of energy and social activity.	**Communication:** An open, social setting for conversation
Comfortable, welcoming, warm, homey	Libraries described as having an intimate and positive feel; sensory experiences create comfort and nostalgia; users can unwind and relax.	**Relaxation:** A calm space for taking a break
Inclusive, accepting, neutral, place for everybody, overlapping, ambivalent, contradictory, uneasy, tense	People from diverse backgrounds feel welcome; different atmospheres coexist (e.g., noisy vs quiet areas), encouraging users to adapt, explore, and navigate complex experiences.	**Exploration:** Stimulating environment

Accordingly, the criteria for selecting case studies in the Tri-City area will be derived from the identified contemporary trends, with particular emphasis on spatial configurations that demonstrate distinctive daylighting strategies and clearly defined movement patterns.

1.4. Libraries in Tri-City Region

The libraries in the Tri-City area of Poland (Gdańsk, Gdynia, and Sopot) stand as significant cultural and architectural landmarks, harmoniously blending modern design with historical elements to create dynamic spaces that foster community engagement and intellectual growth.

In conducting research on the availability of physical libraries within the Tricity area - comprising Gdańsk, Gdynia, and Sopot - a credible and comprehensive resource could be the library catalog found on Trojmiasto.pl. Trojmiasto.pl is a well-established local portal that provides detailed information on a variety of local services, events, and institutions. The library catalog specifically lists numerous libraries, complete with essential details such as addresses, contact information, and operational hours, making it an invaluable tool for both residents and visitors. The reliability of Trojmiasto.pl is underscored by its frequent updates and extensive coverage of the Tricity region, ensuring users have access to the most current information.

A search for "library" - or ‘biblioteka’ - on this platform yields 127 results, encompassing public libraries, academic libraries, and special libraries. Specifically, the catalog includes 74 libraries in Gdańsk, 11 in Sopot, and 33 in Gdynia. Below a description of one of the most Iconic library designs is narrated. This library is a standalone library completed after 2006 featuring the identity of the 21st century libraries. However, since it is a university library further detailed study on this library is beyond the scope of this research.

Main Library of the University of Gdansk, Gdansk

As one of the most Iconic libraries in Tri-city and even Pomeranian region, the library of the university of Gdansk as a standalone modern building acts as a lively center of learning for the academics and university students. The main library was officially established and completed in the year 2006 after the start of its construction in the early 2000 (Czechowska-Derkacz, 2016).

During a visit to the building in a late October, the exterior experience unfolds through the interplay of architectural design and daylight. Access is provided through four entrances—two each on the northeastern and southwestern façades. However, due to security, only the southwestern entrances remain open, requiring visitors to traverse the building’s perimeter. Midday movement is directed northward for several reasons. First, the external capsules, housing individual workspaces, and the staircase, visible from the north, draw attention (Fig. 1.6). The capsules feature large windows, oriented northwest, enhancing the natural light and encouraging further exploration of these architectural features. The wall facing north-east is totally glazed and the capsules are directed toward north-east to allow diffused daylighting devoid of southern and western glare suitable for focused study. The space in front of the glazed façade provides a mixture of soft-seating areas for group discussion and work, especially the areas closer to the façade (Fig. 1.7b and 1.7c), while the areas around the main atrium are used for more focused study with daylight availability from the skylight (Fig. 1.7c). These areas are also next to the bookshelves allowing for direct access to the references (Fig. 1.7c).

Figure 1.6. the exterior of the UG main library consisting of the pictures of northeast façade (a), southeast façade (b), and the stairs on the northwest façade (c) (Pictures by Mosleh Ahmadi).

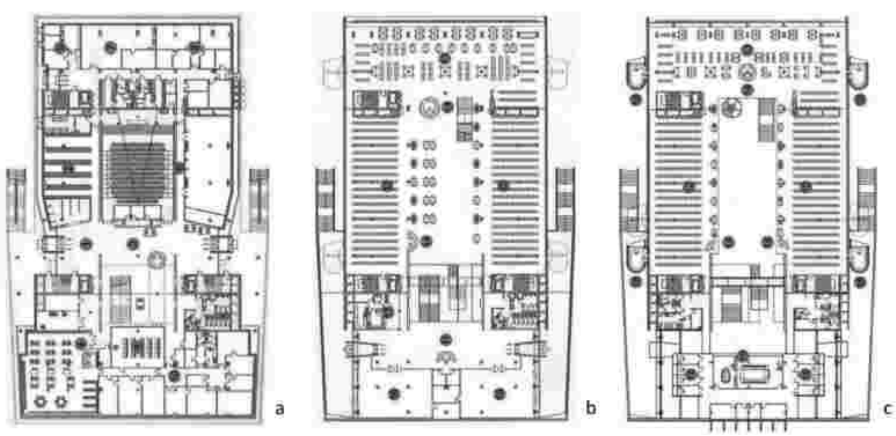


Figure 1.7. Architectural plans of the main library of the UG including ground floor (a), first floor (b), and second floor (c) (Source: Hamerska, 2021). The plans are oriented toward northeast at top.

Upon reaching the upper landing, the visitors face a locked exhibition room, prompting them to return downstairs. The second reason for heading north is the green space (Fig. 1.6a) along the path, offering a more pleasant walk than the car-filled southern façade (Fig 1.6b). Additionally, the north-eastward direction helps avoid the afternoon glare, as no shading devices could completely mitigate the intense western sunlight.

Daylighting plays a key role in shaping the experience. As visitors turn northwest, a pond comes into view, with daylight reflected off a glazed wall, creating playful visual interactions. The reading furniture visible through these windows serves as another stimulus to enter. Moving further, the building's symmetry becomes apparent, with mirrored capsules and staircases on both sides. The intense sunlight on the southern façade speeds up movement, encouraging visitors to reach the shaded, book-themed staircase (Fig. 1.6c).

The steps of this staircase feature painted risers representing famous Polish literary works housed in the library, inviting careful inspection and slowing the ascent. At the landing, a reading hall is visible through glazed windows, where daylight pours in, showcasing the study area's calm atmosphere. However, the locked doors prevent direct entry, and visitors must circle down to the ground floor, where daylight continues to guide the spatial experience.

The study areas on either side of the building, adjacent to the staircase, foster an environment of communication and exploration. These spaces benefit from direct access to the outdoors and ample daylight through the transparent glazed façade. To minimize glare, the façade has been set back from the building. This design allows the southern façade to extend and provide vertical shading for the windows (Fig. 1.8a).

1.4.1. Case Study Selection

The year 2004, is selected as the starting point of the case study selection due to several reasons. First and most importantly, 2004 is the year Poland became a member of the EU and received funds for the improvements of the Polish infrastructures and further developments. The improvement of the library infrastructures was one of these developments. For example, European Solidarity Center in Gdansk in the tri-city that includes a large library archive was completed based on the EU funds (Kowalski et al., 2019, p. 199). In addition, in Poland major digitization efforts commenced in 2004, leading to the official launch of the "Digital Library" in 2006 (Richards et al., 2015, P. 69) that affected the way libraries are perceived.

Figure 1.8. The western view of the building (a) and the seating area in the western side of the building creating an atmosphere of communication by specific daylighting and spatial arrangement (b) (Pictures by Mosleh Ahmadi).

To select case studies for public library buildings in the Tri-City area of Poland, the following criteria are applied (Fig. 1.9): The library must be publicly accessible, ensuring it serves the general public. It should have been completed after 2004, a pivotal year for Poland due to its accession to the EU and the beginning of significant digitalization efforts in Polish libraries. This date also marks a period of evolving library design trends, including the pluralism of roles and the duality of experience in library spaces. Additionally, the library must have been originally designed as a library and not repurposed from another building type. Finally, it should be a standalone structure rather than part of a larger complex, to simplify spatial control. The selection process involves filtering libraries based on these criteria to compile a list of relevant case studies that align with contemporary trends and regional developments.

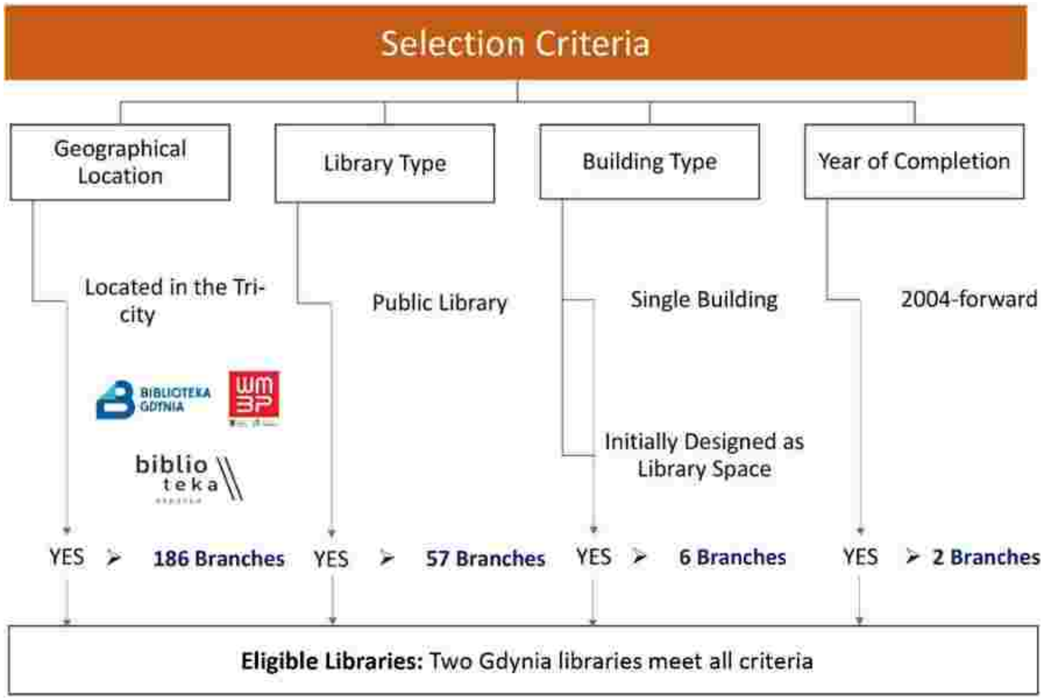


Figure 1.9. Library building case study selection graph (Source: Author).

Following a thorough review of the results retrieved from the online catalog, three major public library systems and their branches were selected for further detailed study. These libraries – comprising 30 branches in Gdansk, 7 in Sopot, and 20 in Gdynia – were chosen because they are the only public libraries with standalone buildings constructed after 2004. The remaining 70 libraries were excluded as they either serve as university or school libraries or are part of larger, multi-purpose complexes or are completed before 2004 and considered as heritage. To sum up from the diagram (Fig. 1.9), the selection criteria for this research are:

1. Library is identified as public library
2. Library building is completed after 2004 and is originally designed as library space
3. Library is a single building to allow an easier control over the space

In the tri-city region, only in Gdynia libraries that meet the criteria were found and among the 20 branches of public library in Gdynia, only two branches met the criteria of selection. Witamino and Maly Kack libraries are the two public libraries that are single buildings and specially designed as libraries after 2004.

The composite map below (Fig. 1.10) illustrates the distribution of all 57 local public libraries across the Trójmiasto region, with dark brown, dark green, and dark violet dots representing the cities of Gdynia, Sopot, and Gdańsk, respectively. From an urban planning perspective, while the placement of libraries generally provides fairly equal access for residents across Trójmiasto, certain neighborhoods, such as Osowa in Gdańsk, remain underserved and would benefit from the establishment of indoor public libraries. Additionally, aside from two libraries in Gdynia - Maly Kack and Witomino - there are no standalone, modern public libraries that serve as prominent landmarks for neighborhoods, individual cities, or the Trójmiasto metropolitan area as a whole.

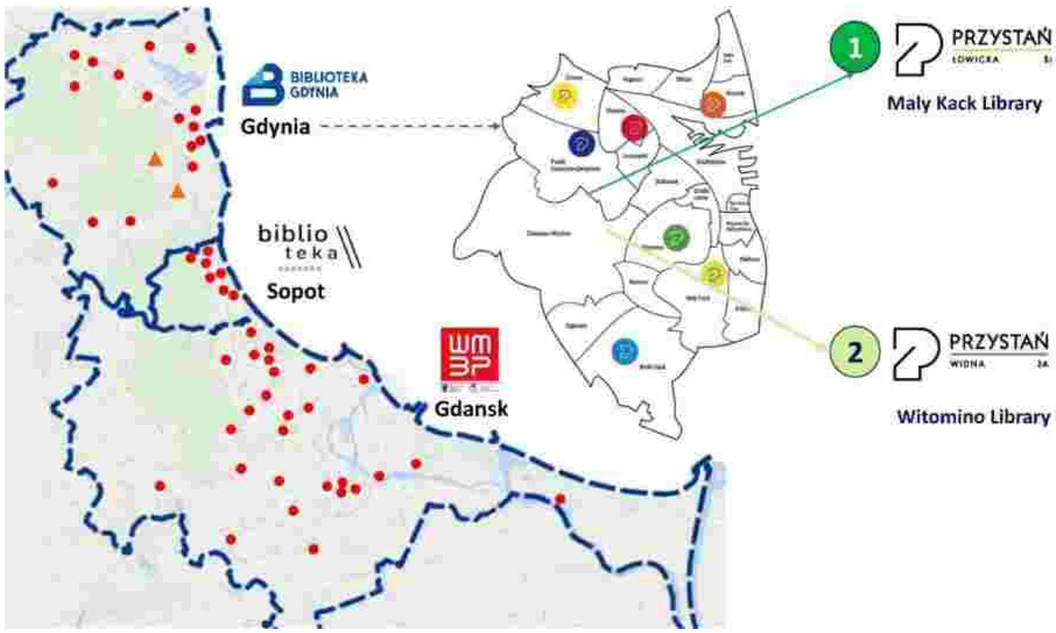


Figure 1.10. Main public libraries in the Tri-city region (the map is screenshot from https://mapcarta.com/Pomorskie/Map) (source: Mapcarta. n.d.). The top right picture is the map of Gdynia city with its borders depicted by Huang et al. (2021). The two selected libraries are adjacent to two community centers in Gdynia.

Below is a full description of the public libraries in Tri-city region:

Provincial and Municipal Public Library of Joseph Conrad Korzeniowski in Gdansk

Recognized as '*Wojewódzka i Miejska Biblioteka Publiczna im. Josepha Conrada Korzeniowskiego*', the Provincial and City Public Library named after Joseph Conrad-Korzeniowski in Gdańsk is the primary public library in the Pomeranian Voivodeship and the largest cultural institution in Gdańsk (Kaszubopedia, 2022).

It is funded by the Pomeranian Voivodeship self-government and the city of Gdańsk and its headquarters is located at Targ Rakowy 5/6 in Gdańsk. Its beginnings date back to April 1945. In 1955, a restructuring of Gdańsk librarianship took place, resulting in the establishment of the Provincial and City Public Library. Twenty years later, it was renamed the Provincial Public Library, and in 1994, Joseph Conrad-Korzeniowski became its patron. In 2003, there was another name change - to the Provincial and City Public Library (abbreviated as WiMBP).

The main tasks of the institution include collecting, processing, and providing access to collections in 30 branches. Among them are modern libraries like the Manhattan Library, large district branches - Oliwa Library, Pilots' Library, Chełm Library, City Hall Library, Żabianka Library, as well as small, intimate ones, such as the Turtle Library, Lavender Library, or Gdańsk Branch. Additionally, the institution oversees the substantive supervision of the network of local public libraries in the Pomeranian Voivodeship. It also conducts educational, cultural, and publishing activities, while also focusing on the Pomeranian regionalism. In addition to typical library branches, WiMBP houses the American Corner, established in cooperation with the United States Embassy in Warsaw, and the Shanghai Cabinet promoting knowledge about China. It also has departments for Promotion, Marketing, and Public Relations, Instructional-Training, Regional, Collection Development, Collection Management, City Network Organization, Information Technology, Personnel Affairs, Financial-Accounting, and Administration (Kaszubopedia, 2022).

All in all, as it was mentioned earlier, the year 2004 marked a significant turning point in the quest for self-definition and pluralism of roles for libraries, a process closely connected to the renaming of the Provincial and City Public Library in Gdańsk to the Joseph Conrad-Korzeniowski Library just a year earlier in 2003 to build on the identity of this library. In addition, the 30 branches of this public library are in line with the expansion of the role of library in the 21st century. Below the list of these public libraries are depicted in a table 1.3.

Table 1.3. WiMBP library branches (Adapted from Trójmiasto.pl, n.d.; Gmina Miasta Gdańska, n.d.; Wojewódzka i Miejska Biblioteka Publiczna im. J. Conrada-Korzeniowskiego w Gdańsku, 2024)

NO	**Library Branch**	**Years of Establishment and Completion**	**Current Building as for 2024**	**Building Type**
1	Biblioteka Kokoszki	Library: 2014 Building: 2014	street Azaliowa 18 80-177 Gdańsk Kokoszki	Part of a school
2	Biblioteka Brzezno	Library: N/A Building: N/A	street Dworska 27 80-506 Gdańsk Brzeźno	Part of an aged building

3	Biblioteka Babie Lato	Library: 1974 Building: N/A	street Opolska 3 80-395 Gdańsk Przymorze	Part of a pre-existing building
4	Bibioteka bez Barier	Library: 1991 Building: Pre-existing, N/A	street Czerwony Dwór 21 80-376 Gdańsk Przymorze	Part of a pre-existing building
5	Biblioteka Chelm	Library: 2021 Building: Interior renovated in 2020	street Dragana 26 80-807 Gdańsk Chełm	Part of a pre-existing building
6	Pracownia Regionalna	Library: N/A Building: 1929	Targ Rakowy 5/6 80-806 Gdańsk Śródmieście	Part of the pre-existing Polish Post Office
7	Biblioteka Glowna	Library: N/A Building: 1929		
8	American Corner	Library: 2008 Building: 1929		
9	Biblioteka Manhattan	Library: 2004 Building: 2004	al. Grunwaldzka 82 80-244 Gdańsk Wrzeszcz	Located in a Shopping Center
10	Biblioteka na Grobli	Library: N/A Building: Aged Building	street Angielska Grobla 8/10 80-756 Gdańsk Śródmieście	Part of a pre-existing building
11	Biblioteka pod Kotem i Mysza	Library: N/A Building: Aged	street Lelewela 21/22 80-442 Gdańsk Wrzeszcz	Part of a pre-existing building
12	Biblioteka Ratuszowa	Library: N/A Building: Heritage, 1867	ul. Gościnna 1 80-032 Gdańsk Orunia	Part of the Urunia Townhall
13	Filia Gdanska	Library: 2008 Building: Heritage	street Mariacka 42 80-833 Gdańsk Śródmieście	Historic building in Oldtown
14	Biblioteka Kolonia	Library: N/A Building: Aged	street Manifestu Połanieckiego 32-34 80-406 Gdańsk Wrzeszcz	Part of a pre-existing building
15	Biblioteka Morenowa	Library: N/A Building: N/A	street Wyrobka 5A 80-288 Gdańsk Piecki-Migowo	Part of a pre-existing building
16	Biblioteka na Stogach	Library: N/A Building: Aged building	street W. Stryjewskiego 29 80-620 Gdańsk Stogi	Part of a pre-existing aged hospital
17	Biblioteka Pilotow	Library: N/A	street Pilotów 3 80-460 Gdańsk Zaspa	Part of a pre-existing building

		Building: Aged building		
18	Biblioteka Portowa	Library: N/A Building: heritage renovated in 1989	street Strajku Dokerów 5 80-544 Gdańsk Nowy Port	Part of ŁAŹNIA II Center for Contemporary Art building
19	Biblioteka Niedźwiednik	Library: N/A Building: Aged building	street Podkarpacka 1 80-292 Gdańsk Niedźwiednik	Part of Post office building
20	Biblioteka Przeróbka	Library: N/A Building: Aged building	street Kryniczna 20 80-708 Gdańsk Remaking	Part of a pre-existing building
21	Biblioteka Suchanino	Library: N/A Building: Aged building	street Paderewskiego 11 80-169 Gdańsk Suchanino	Part of Post office building
22	Biblioteka Lawendowa	Library: 2020 Building: 2019	ul. Lawendowe Wzgórze 5 80-175 Gdańsk	Part of a school
23	Biblioteka na Fali	Library: N/A Building: +50 years aged building	street Jagiellońska 8 80-371 Gdańsk Przymorze	Part of a pre-existing building
24	Biblioteka na Wyspie	Library: N/A Building: N/A Heritage building	street Turystyczna 3 80-680 Gdańsk Sobieszewo	Library was opened in a heritage building
25	Biblioteka na Strzyży	Library: 2017 Building: N/A, aged building	street Chopina 40 80-272 Gdańsk Strzyża	Part of a pre-existing building
26	Biblioteka Oliwska	Library: 2000 Building: N/A	street Opata J. Rybińskiego 9 80-320 Gdańsk Oliwa	Part of a pre-existing building
27	Biblioteka pod Żółwiem	Library: N/A Building: N/A Heritage	street Saint Ducha 111/113 80-834 Gdańsk Śródmieście	Located in a pre-existing heritage building
28	Biblioteka przy Rynku	Library: 1992 Building: N/A aged building	ul. Czerwony Dwór 21 80-376 Gdańsk Przymorze	Part of a pre-existing building
29	Biblioteka Żabianka	Library: 1970 Building: N/A	street Gospody 3b 80-344 Gdańsk Żabianka	Part of a pre-existing building

30	Filia Naukowa	Library: N/A Building: N/A aged building	street Obrońców Wybrzeża 2 80-398 Gdańsk Przymorze	Part of a pre-existing building

According to the table above (Table 1.2), in the WiMBP library branches there is no single building library. Of course, Lawendowa Library, Kokoszka Library, and Manhattan meet one or two criteria of the selection, but they could not be selected since they are a part of another complex. The first two are built in conjunction with school and therefore could have the title of school library, and the latter one is located inside a shopping mall.

Józef Wybicki Municipal Public Library in Sopot

The Municipal Public Library in Sopot or Miejska Biblioteka w Sopocie (MBP), named after Józef Wybicki, was founded on December 7, 1946. It aims to facilitate access to culture, entertainment, and education through its diverse collections and cultural activities. The library is committed to fostering reading and creating dynamic community spaces for all age groups. It provides various services, including e-books, audiobooks, and educational programs, and organizes events for children, adults, and seniors. The Municipal Public Library in Sopot operates several branches to serve the local community. They are depicted in the Table 1.4 in detail.

Table 1.4. MBP library branches (Adapted from Miejska Biblioteka Publiczna w Sopocie, n.d.)

NO	**Library Branch**	**Years of Establishment and Completion**	**Current Building as for 2024**	**Building Type**
1	Kamionka	Library: N/A Building: N/A	ul. Mazowiecka 26, 81- 862 Sopot	Part of a pre-existing building
2	Przylesie	Library: N/A Building: N/A	ul. 23 Marca 32, 81-820 Sopot	Part of a pre-existing building
3	Literacka	Library: N/A Building: N/A	ul. Józefa Kraszewskiego 26, 80-814 Sopot	Part of a pre-existing building
4	Broadway	Library: N/A Building: N/A	ul. Kolberga 9, 81-881 Sopot	Part of a pre-existing building
5	Koc i Książka	Library: N/A Building: N/A	ul. Kazimierza Wielkiego 14, 81-729 Sopot	Part of a pre-existing building
6	Miniteka	Library: N/A Building: 1946	ul. Jakuba Goyki 1, 81-715 Sopot	Single building

7	Sopoteka	Library: N/A Building: 2015	ul. Tadeusza Kościuszki 14, 81-704 Sopot	Part of a shopping mall

Among the 7 branches of MBP, only one branch is a single building library and it is arranged to host users from the age of 1 to 13. The library includes not only book shelves but also facilities for entertainment such as videogame station.

Gdynia Public Library

The Gdynia Public Library or Biblioteka Gdynia is a vibrant cultural institution in Gdynia, Poland, consisting of a central library and 20 branches spread throughout the city. It offers a wide range of services including book lending, cultural events, educational programs, and digital resources. The library focuses on promoting literacy, lifelong learning, and community engagement. Each branch provides tailored activities and services to meet the needs of its local community. Below the detailed information on each of these branches is tables (Table 1.5).

Table 1.5. library branches (Adapted from: Biblioteka Gdynia, n.d.)

NO	**Library Branch**	**Years of Establishment and Completion**	**Current Building as for 2024**	**Building Type**
1	Biblioteka Butikowa	Library: N/A Building: N/A	Ul. Wiczlińska 50A, 81-578 Gdynia	Part of a building
2	Biblioteka Chylonia	Library: N/A Building: N/A	ul. Opata Hackiego 33, 81-062 Gdynia	Part of a building
3	Biblioteka Chylonia Centrum	Library: N/A Building: N/A	ul. Kartuska 20 B, 81-002 Gdynia	Part of a building
4	Biblioteka Cisowa	Library: N/A Building: N/A	ul. Chylońska 237, 81-007 Gdynia	Part of a building
5	Biblioteka Dąbrowa	Library: N/A Building: N/A	ul. Nagietkowa 73, 81-589 Gdynia	Part of a building
6	Biblioteka Działki Leśne	Library: N/A Building: N/A	ul. Warszawska 3, 81-314 Gdynia	Part of a building
7	Biblioteka Grabówek	Library: N/A Building: N/A	ul. Morska 113, 81-222 Gdynia	Part of a building
8	Biblioteka Kamienna Góra	Library: N/A Building: N/A	Al. J. Piłsudskiego 18, 81-378 Gdynia	Part of a building
9	Biblioteka Karwiny	Library: N/A Building: N/A	ul. Brzechwy 3/5, 81-590 Gdynia	Part of a building

10	Biblioteka Mały Kack	Library: N/A Building: 2021	ul. Łowicka 51, 81-504 Gdynia	Single building
11	Biblioteka Obłuże	Library: N/A Building: N/A	ul. Boisko 6, 81-183 Gdynia	Part of a building
12	Biblioteka Oksywie	Library: N/A Building: N/A	ul. Podchorążych 10a, 81-133 Gdynia	Part of a building
13	Biblioteka Pogórze	Library: N/A Building: N/A	ul. Wadm. K. Porębskiego 21, 81-185 Gdynia	Part of a building
14	Biblioteka Pustki Cisowskie	Library: N/A Building: N/A	Ul. Chabrowa 43, 81-079 Gdynia	Part of a school
15	Biblioteka Śródmieście	Library: N/A Building: N/A	ul. Władysława IV 7-15, 81-353 Gdynia	Part of a building
16	Biblioteka Wiedzy	Library: N/A Building: N/A	ul. Świętojańska 141, 81-404 Gdynia	Part of a building
17	Biblioteka Witomino	Library: 2020 Building: 2020	ul. Widna 2B, 81-649 Gdynia	Single building
18	Wypożyczalnia Centralna	Library: N/A Building: N/A	ul. Abrahama 60, 81-395 Gdynia	Part of a building
19	Biblioteka Wzgórze	Library: N/A Building: N/A	ul. Biskupa Dominika 3, 81-402 Gdynia	Part of a building
20	Biblioteka z Pasją	Library: 2017 Building: N/A	al. Zwycięstwa 96/98 (PPNT, bud. IA), 81-451 Gdynia	Connected to a pre-existing cultural center

1.4.2. Selected Case Studies

The study of the libraries in the Tri-City area, specifically those meeting the criteria of being public libraries, built post-2004, and housed in single-purpose buildings, highlights their role as modern cultural landmarks. Gdynia's Witamino and Maly Kack libraries exemplify this blend of modern design and community-focused functionality. These two libraries are also adjacent and connected to the two community centers so-called Przystan Widna 2A, and Przystań Łowicka 51, respectively. These libraries not only provide extensive collections and services and serve as dynamic community spaces that promote literacy, education, and cultural engagement in the 21st century but also enjoy a well-designed interior that consider proper daylighting and community engagement.

Chapter Two

Research Design and Survey

In the following chapters, the experimental design - building on the foundation laid in the literature review - will be detailed. These chapters will thoroughly explain the processes of data collection, data wrangling, and analysis. This chapter specifically focuses on the architectural analysis of the selected case studies and presenting the research questionnaire, which was developed based on a review of relevant literature, along with the methods used for behavioral data collection. Additionally, preliminary results will be presented to support the creation of subjective profiles for the case studies, derived from the questionnaire responses.

2.1. Architectural Characteristics and Spatial Qualities of the Case Studies

Biblioteka Maly Kack

The Maly Kack Library, an extension of the Gdynia Library, serves as a local library with a child-friendly interior, located adjacent to a community center. The library was completed by Maciej Walczyna (Trop studio) in 2021. Despite its proximity to a primary school, it is designed to cater to the broader community rather than functioning solely as a school library (Fig. 2.1). the standout features observed from the first visit that make this library a unique and inspiring space could be described as below.

Mały Kack is presented as a district where a new local center is being developed to support everyday community needs. The project introduces a multifunctional public building that combines a library with social and cultural spaces, forming a hub for interaction and local identity (Gdynia.pl, 2019). The building itself is described as a modern and unconventional library, featuring an expressive interior with playful elements such as a slide connecting levels, creating an engaging and dynamic environment for users of different ages (WhiteMAD, 2022).

From the first visit, the architectural brilliance of the Maly Kack Library is captivating. The library’s two floors are connected by a central circular staircase (Fig. 2.2), creating a harmonious flow of movement and visual connection between levels. This design not only facilitates movement but also ensures a strong visual connection throughout the space, allowing visitors to appreciate the library's full breadth. The staircase also includes a space for a screen, where visitors can sit and enjoy educational content or entertainment. This multifunctional aspect enriches the library’s offerings and fosters a community-oriented atmosphere. Adding a touch of fun, a slide runs alongside the staircase. This playful element emphasizes the library's dynamic and engaging environment, making it a delightful place for children and adults alike.

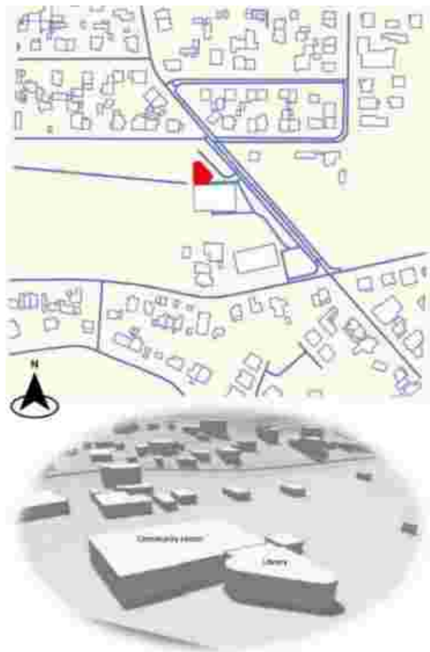


Figure 2.1. The placement of the library in the terrain and its juxtaposition with the neighboring buildings (Illustration is taken from cadmapper.com (top) and Spacio.ai (bottom)).

Figure 2.2. The entrance of the Maly Kack Library (a). The main staircase featuring a slide and the front steps that serve as a soft seating area for the media screen (b) (Pictures: Mosleh Ahmadi on 07.06.2024, 16:00).

A relatively large circular skylight with metal frames crowns the staircase, bathing both floors in natural light (Fig. 2.3a). This feature enhances the library's open, airy feel and provides an inviting atmosphere for all visitors. Thoughtfully installed windows at the junction between the ceiling and walls above the bookshelves allow additional natural light to permeate the space (Fig. 2.3b). This design choice lightens the ceiling's appearance and enhances the overall ambiance.

On the upper floor, circular lighting fixtures hang from the skylight, promoting a circular movement pattern around the staircase. This encourages visitors to explore the shelves and engage with the library's resources dynamically. The edge of the staircase doubles as a desk, providing a well-lit area for reading (Fig. 2.3c).

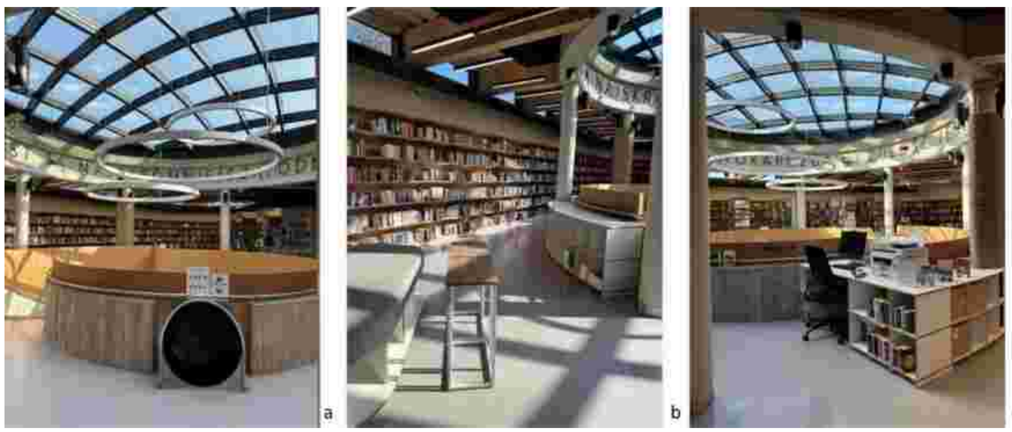


Figure 2.3. The above floor showing the skylight, slide entrance (a), windows, shelves (b), and the staircase edge (c) (Pictures: Mosleh Ahmadi on 07.06.2024, 16:00).

The spatial design of the first-floor features more static space with tables positioned behind the main staircase, offering isolated areas for focused study (Fig. 2.4a). The library's location in a residential neighborhood in which external distractions are minimized allows for large, transparent windows (Fig. 2.4b). This transparency not only enhances the aesthetic appeal but also ensures effective daylighting for the lower floor compensating for areas where the skylight alone might be insufficient (Fig. 2.4c).

Overall, The Maly Kack Library exemplifies a thoughtful integration of architectural design and functional efficiency. Its child-friendly elements, effective use of natural light, and innovative structural features make it a valuable community resource that promotes learning and engagement for all users. The experience of the architectural atmospheres of the Maly Kack Library is both communication oriented and concentration oriented.

Figure 2.4. The study area (a), transparent glazed walls covered by mini bookshelves in front (b), and the daylighting condition (c) in the first floor of the library (Pictures: Mosleh Ahmadi on 07.06.2024, 16:00).

Biblioteka Witomino

An article titled *"Modern neighborhood center. Gdynia's answer to residents' needs"* on *Architektura i Biznes* was written by Marta Kowalska (2021). It discussed the development of the neighborhood center in Gdynia's Witomino district, focusing on the project's community-oriented design and architecture. Residents highlighted the need for a modern neighborhood club. In a response to meet this need, the project was selected through an architectural competition and later developed by a design team consisting of PB Studio, Studiomania, and IPA Ipreferanalog (Architectural Digest Polska, 2024). One of the competition juries describes the design as follows (Kowalska, 2021):

> The winning concept flawlessly solves functional issues, combining and dividing interiors and outdoor areas. A flexible, capacious space was obtained, and at the same time not devoid of places conducive to integration in smaller groups. The architects skillfully used the terrain to create a friendly, inviting place. The concept is coherent, consistent and carefully thought-out, while the form of the object is adequate to its function, meeting the expectations of openness and transparency without resorting to forms characteristic of commercial or office buildings.

It is apparent that not only the ideas of openness and transparency, but also the creation of the atmosphere of communication in a library had been attributed to the concept of design even before the building was erected. The Witamino Library is consisted of two separated buildings that are in two floors. Building B houses the circulation desk and book shelves while building A is housing mostly spaces of community engagement that serves as a community center called Przystan Winda 2 (Fig. 2.5).

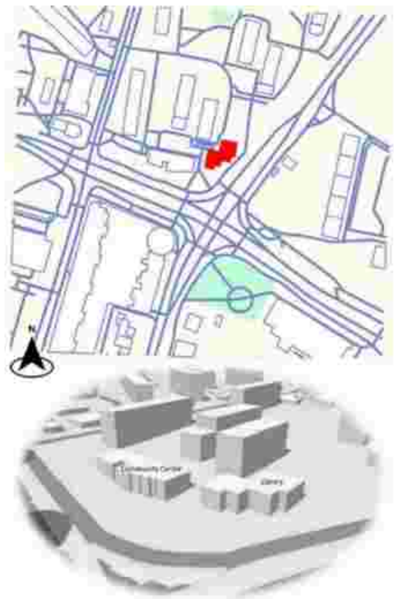


Figure 2.5. The placement of the library in the terrain and its juxtaposition with the neighboring buildings (Illustration is taken from cadmapper.com (top) and Spacio.ai (bottom)).

In contrast to the Maly Kack Library, this library improves interaction with the northern exterior while maintaining a sense of introversion on the southern façade. Specifically, the building is shielded from direct sunlight and noise originating from the adjacent cross-section to the south and southwest through a vertically gridded façade. This gridded façade extends to the balconies of both blocks, providing protection for the communal areas from both environmental factors and the adjacent cross-section's impact (Fig. 2.6).

The vertically segmented façades on the southwest and southeast sides of the both community center and the library serve as vertical shading elements, reducing glare while allowing views from the communal spaces (see Fig. 2.7a and 2.7b). In contrast, the north façade of the community center benefits from ample daylight through fully transparent glazed walls or large windows, which extend the interior space toward the semi-open areas and balconies. To filter the incoming light and enhance shading, a perforated horizontal screen is installed on the glazed walls (see Fig. 2.7c and 2.7d). In addition, the large windows allow a soft seating area for the readers who are passing the corridors of the library (Fig. 2.8a, and 2.8b).

Figure 2.6. Interaction of the southeastern (a), southwestern (b), and northwestern (c) façades of the library with the exterior space (Pictures by Mosleh Ahmadi on 07.06.2024, 14:00).

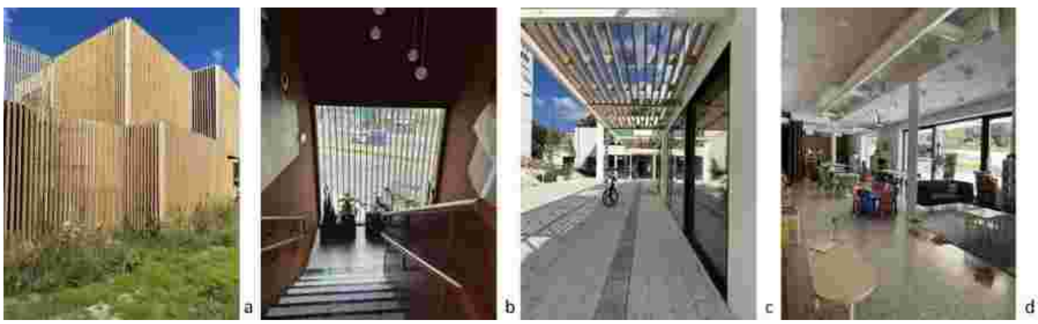


Figure 2.7. The shading system for the southwestern façade of the library (a, and b), and the shading system for the northern façade of the community center (c, and d) (Pictures by Mosleh Ahmadi on 07.06.2024, 14:00).

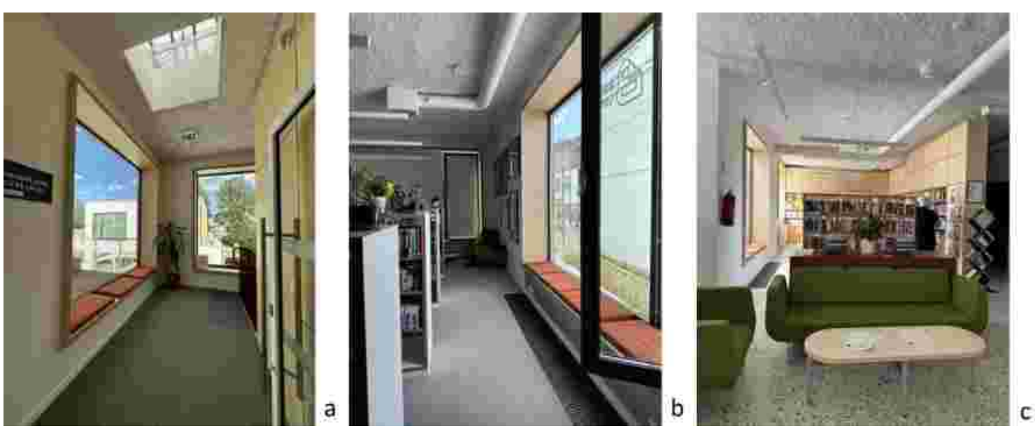


Figure 2.8. Seating options in the interior (Pictures by Mosleh Ahmadi on 07.06.2024, 14:00).

2.2. Functional Mapping and Spatial Categorization of Study Area

Architectural plans of the two libraries were retrieved from Gdynia city hall to model the libraries according to the original plans. First the plans were drawn based on the copies of the original plans and then using rhino software the plan was turned into 3D model. At this time no material was added to the model since the daylighting simulation tool used in this research (AnnuOwl) had the possibility to add material in the programmed components of grasshopper.

Maly Kack Library

Below the 3D model of Maly Kack library and its architectural plan is presented (Fig. 2.9). As described earlier, the building consists of two floors connected by a central circular staircase, above which a large skylight is positioned. This vertical connection not only links the levels physically but also visually anchors the interior space. The circular stair also serves as a central point around which circulation flows radially, encouraging movement throughout the ground floor and facilitating chance encounters among users. On the ground floor, two enclosed cubicles are introduced to provide a degree of isolation within an otherwise open layout. Movable furniture and group seating areas provide adaptability for events or collaborative study, enhancing both comfort and flexibility. This level is predominantly organized around group seating areas, arranged within a transparent envelope of glazed walls. The openness of the plan encourages interaction, movement, and visual connectivity for users. Soft seating and warm materials contribute to a physically pleasant and cozy environment, while the openness and clear sightlines foster informal socialization and visual awareness.

In contrast, the upper floor subtly restrains physical activity by offering a smaller floor area. As a result, quiet browsing and longer periods of stationary use replace the higher levels of movement observed on the ground floor. The reduced floor area, combined with the focused lighting from the skylight, creates a sense of intimacy and visual comfort conducive to concentration. This spatial differentiation generates two distinct atmospheres within the building. The ground floor accommodates communication and collective engagement, while the upper floor supports focused and individual study. The absence of outward window views on the upper level, combined with the presence of a single large skylight, reinforces this atmosphere of concentration. Natural light is directed inward, toward the bookshelves and seating areas, minimizing external distractions and fostering a sense of immersion in reading and study. Overall, the Mały Kack Library emphasizes experiential fluidity and social interaction, while simultaneously providing adaptable and comfortable spaces that respond to both individual and group needs.

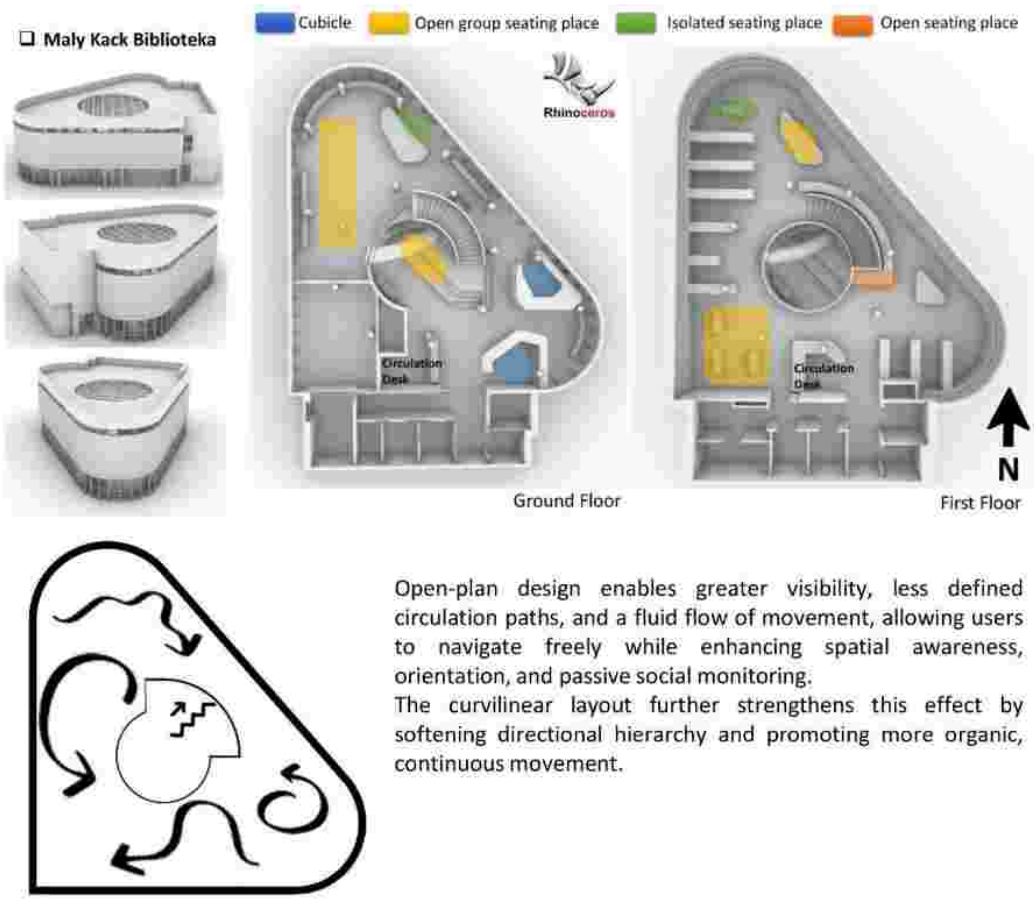


Figure 2.9. Architectural model of Maly Kack library according to the original plan retrieved from Gdynia City Hall (source: author).

The seating areas in the Maly Kack Library can be broadly categorized into five primary locations on the ground floor (Fig. 2.10) and four on the upper floor (Fig. 2.11), each defined by spatial characteristics specific to its immediate context.

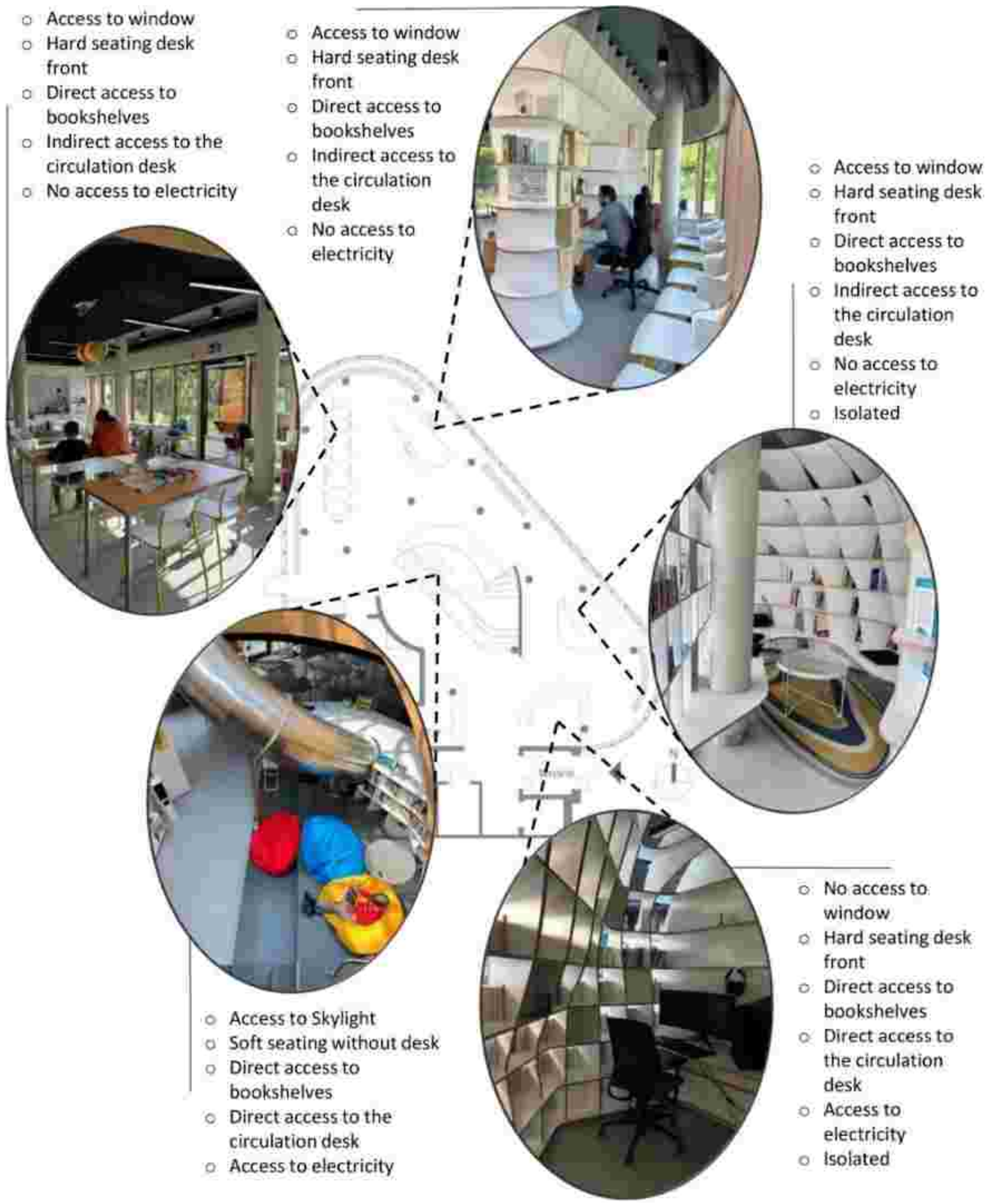


Figure 2.10. Primary seating locations on the ground floor of the Mały Kack Library and their corresponding spatial characteristics.

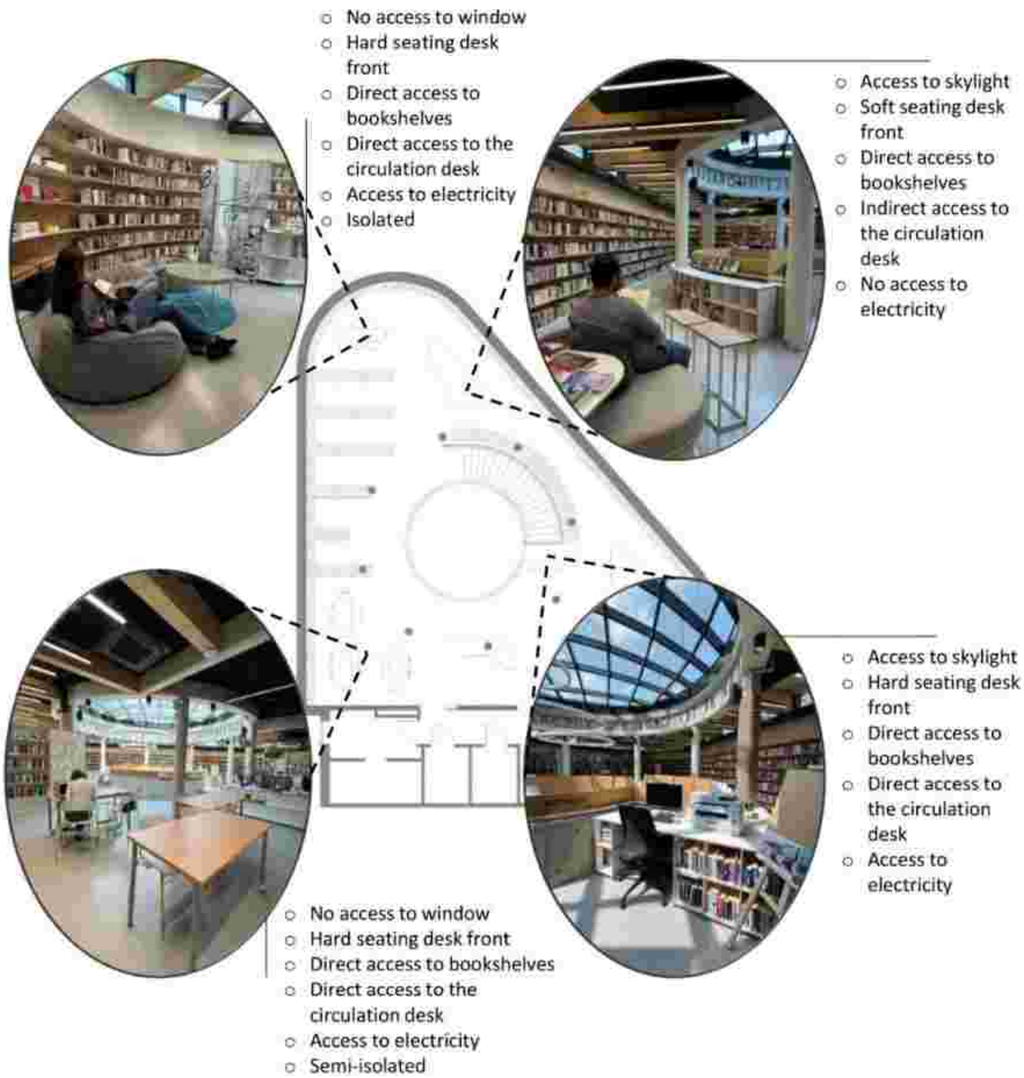


Figure 2.11. Primary seating locations on the first floor of the Mały Kack Library and their corresponding spatial characteristics.

Witomino Library

Below the 3D model of the Witomino Library and its architectural plan is presented (Fig. 2.12). Similar to the Mały Kack Library, this building consists of two floors. The ground floor benefits from a fully glazed northern façade, allowing generous daylight to penetrate the interior. Large windows provide an abundance of natural light, contributing to a bright and visually open environment. The northern light is diffuse, reducing glare and creating consistent visual comfort, while the glazed façade visually connects the interior to the surrounding urban context.

Unlike the Mały Kack Library, however, the spatial organization of this library is more clearly defined and segmented, leaving less room for spatial discovery. Although the ground floor follows an open layout, the upper floor is distinctly divided by large interior glazed partitions that establish clear boundaries between spaces. Vertical circulation between the two floors is facilitated not only by stairs but also by an elevator, reinforcing functional independence between levels. This degree of segmentation enhances acoustic and visual separation, creating stronger spatial isolation both between floors and within the upper level. The segmented rooms, combined with movable furniture, allow controlled flexibility for both focused study and small collaborative meetings. As a result, seating areas suitable for concentrated study are distributed across both floors. In contrast to the Mały Kack Library - where the ground floor is more dynamic and event-oriented - the Witomino Library enables focused activities throughout the building.

The upper floor demonstrates additional flexibility through varied seating arrangements within its segmented rooms. Although these spaces primarily function as reading rooms, they can be reconfigured to accommodate meetings or small group activities. Glazed partitions maintain visual links while enhancing acoustic privacy, allowing users to feel both connected and undisturbed. In the Mały Kack Library, such flexibility is instead concentrated on the ground floor, where the open layout allows for a higher degree of spatial adaptability. Overall, Witomino Library prioritizes controlled spatial definition, acoustic comfort, and adaptable yet structured environments that support both individual focus and purposeful social engagement.

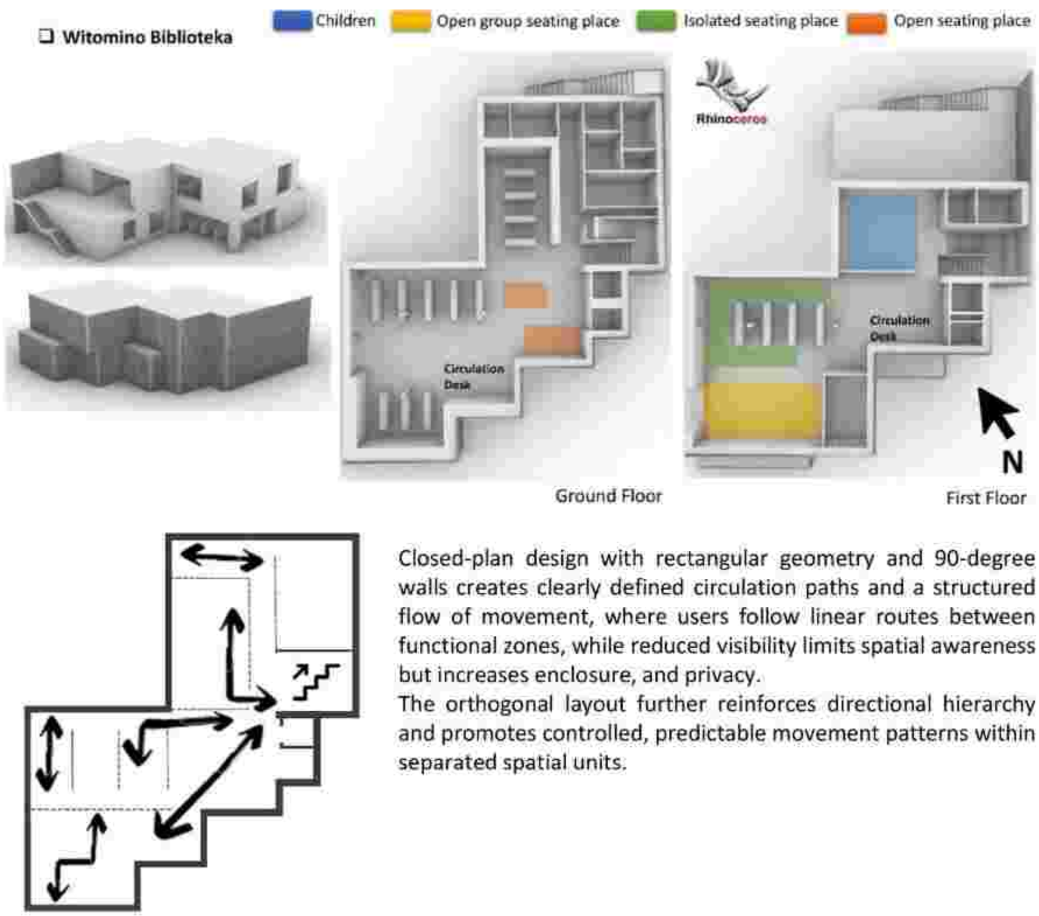


Figure 2.12. Architectural model of Witomino library according to the original plan retrieved from Gdynia City Hall (source: author).

The seating areas in the Maly Kack Library can be broadly categorized into five primary locations on the ground floor (Fig. 2.13) and four on the upper floor (Fig. 2.14), each defined by spatial characteristics specific to its immediate context.

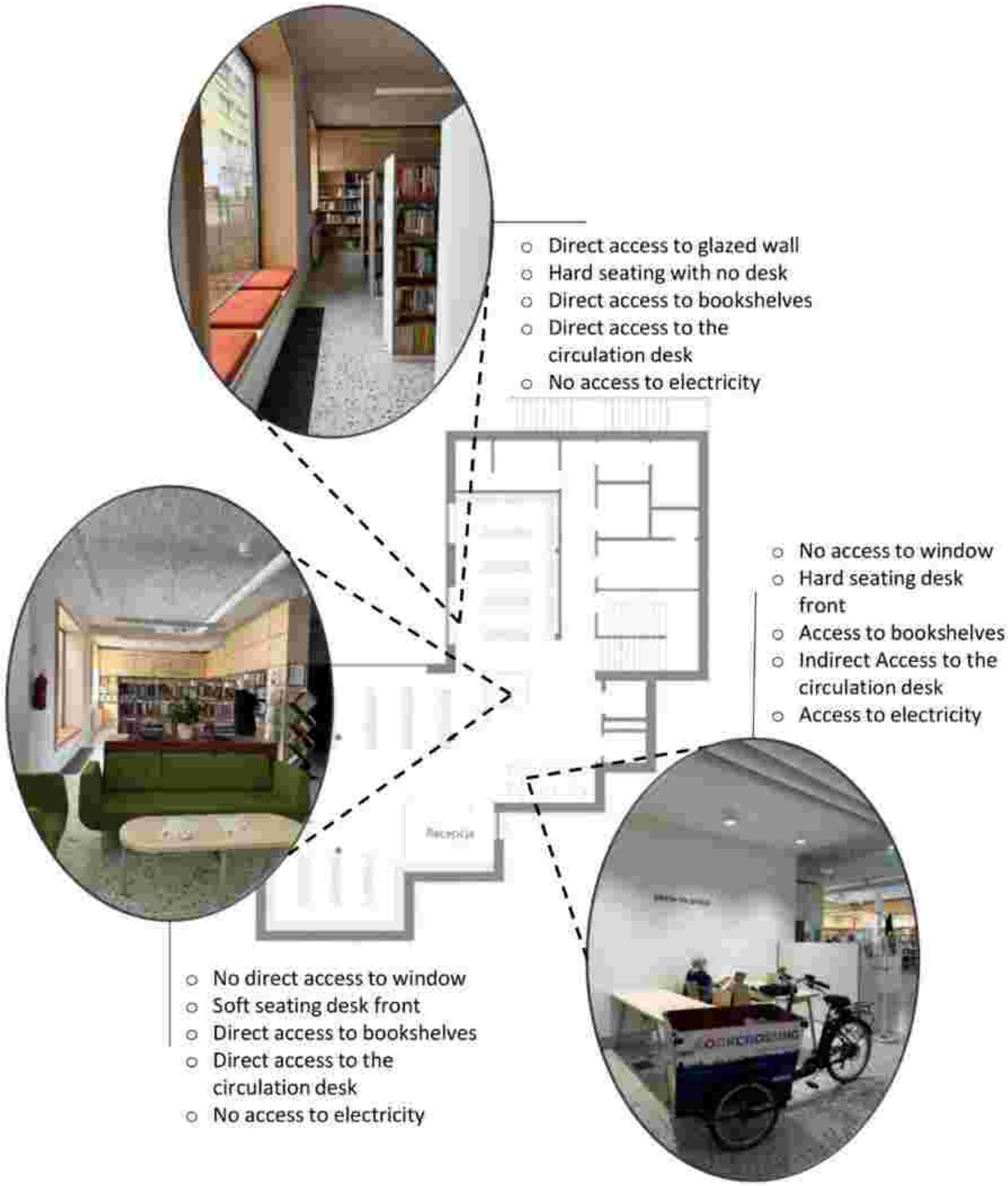


Figure 2.13. Primary seating locations on the ground floor of the Witomino Library and their corresponding spatial characteristics.

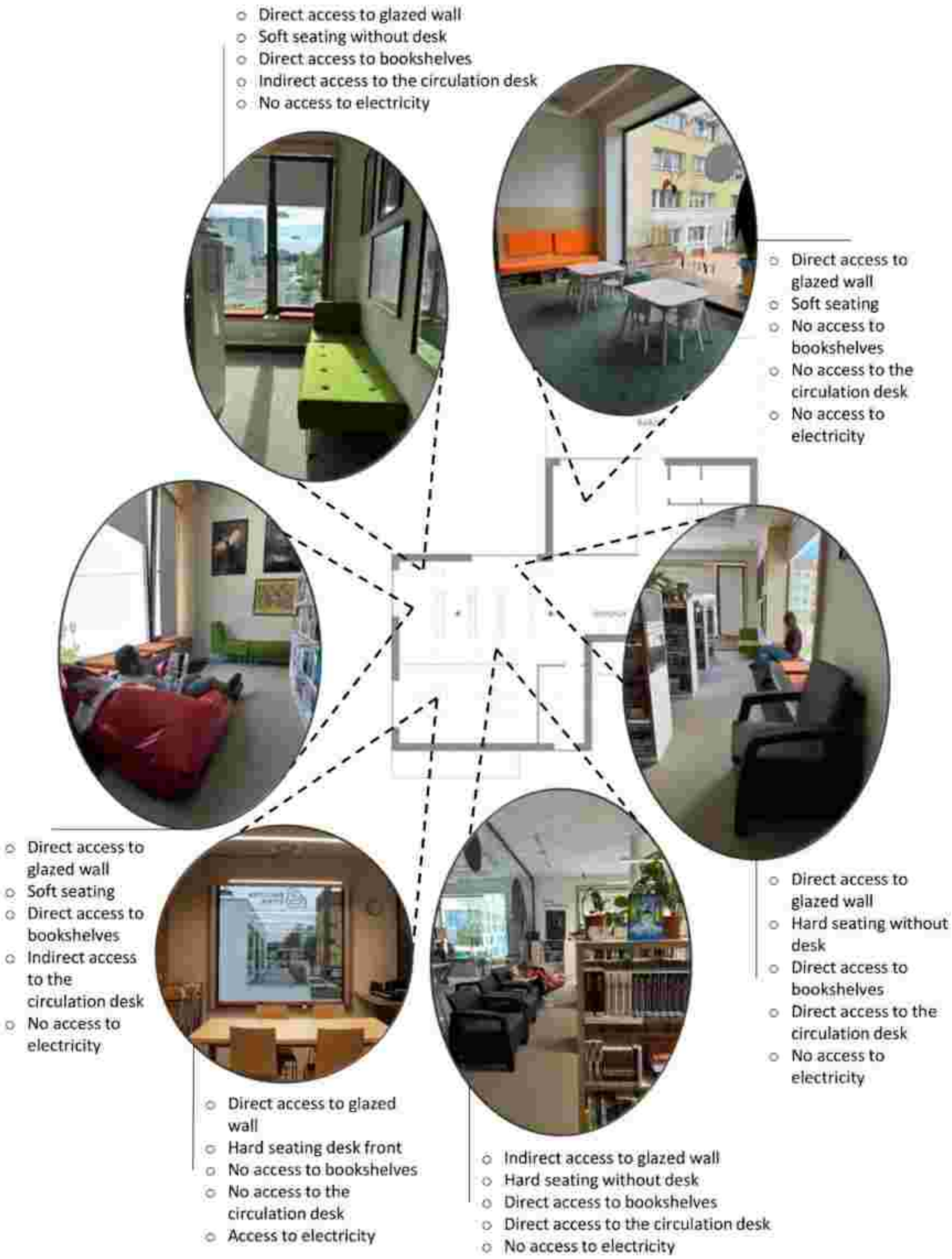


Figure 2.14. Primary seating locations on the ground floor of the Witomino Library and their corresponding spatial characteristics.

2.3. Questionnaire Design

Three types of questionnaires have been developed for this study and translated in Polish language for the respondents. These questionnaires were reviewed and approved by the ethical committee in Gdansk University of Technology.

Questions were designed based on:

- Previous research papers in the subject of study
- Interpretations of the space syntax values
- Initial survey outcomes concerning daylighting condition and the design of the libraries

Before conducting the survey and distributing the questionnaires, 12 sets of questionnaires were printed out and delivered to the director and librarians of each library. Two of these questionnaires were aimed at getting feedback from the librarians and the rest were aimed at the users of the libraries. The distribution of these questionnaires was mainly to assess the readability and convenience of the questionnaires for users and librarians.

During the visit, following the presentation of a letter from the doctoral school addressed to the libraries, three key aspects of the survey were analyzed:

- **Selection of the points**: Identifying the location of the circles (in the observation sheets) representing all seating locations within library.
- **Questionnaire Assessment**: Evaluating the feedback from librarians and directors regarding the clarity and feasibility of the questions included in the questionnaire. In addition, in each library, one questionnaire was filled out by a user that was volunteer and interested in the subject to assess the readability of the material.
- **Survey Timing**: Determining the best timeframe for conducting the main survey, taking into consideration the library's schedule and user availability.

The questions that were verbally asked from the librarians were (Table 2.1):

Table 2.1. Questions that verbally was asked in the interview with the librarians of each of the libraries (Source: author).

Type	Question
Feedback on Questionnaires	What are your thoughts on the clarity and relevance of the questions in the proposed questionnaire?
	Are there any specific questions you believe should be added or modified to better capture user experiences and library usage?
Timing for Experiments	Based on your understanding of library operations, what times do you believe would be most suitable for conducting the experiments?

	Are there particular days or times when user attendance is significantly higher or lower that we should consider
Library Activity	Can you provide insights into the typical user activity patterns during the proposed weeks for the experiments
	Are there any upcoming events or academic deadlines that might impact library attendance during these periods
Logistical Concerns	Are there any logistical challenges or constraints we should be aware of when scheduling the surveys and measurements
	Do you foresee any potential disruptions in library operations during the proposed times
	Do you have any additional recommendations or insights that could help refine our approach to the surveys and measurements
	Is there any other information about the library's space or operations that you believe is crucial for this study

Next, surveys were conducted during three key seasonal periods to capture variations in environmental conditions and user behavior: the Winter Solstice, Spring Equinox, and Summer Solstice. Each questionnaire distribution was carried out over the course of one month. The winter observation took place during the second week of December, just before the Winter Solstice (December 21–22), a time characterized by a low sun angle, colder weather, and shorter daylight hours. This timing was chosen for practical reasons, as user attendance typically drops after mid-December, allowing for pre-solstice measurements. The spring observation was conducted during the third week of March, coinciding with the Spring Equinox (March 19–21), a period of increasing sun angles and milder weather. This week was selected to align with seasonal change while avoiding disruptions in library activity. Lastly, the summer observation occurred in the third week of June, near the Summer Solstice, when the sun angle is highest and daylight hours are longest. This period was selected for its alignment with the solstice and the absence of major holidays or attendance fluctuations.

2.3.1. User Questionnaires

The first set was distributed by the researcher and librarians to random users willing to respond at various times to increase the sample size and diversity of responses (Figs. 2.15-20). These questionnaires were distributed to the users of the libraries (in Polish language) willing to fill out the questionnaires in December, March and June to gather subjective ratings and data on winter and summer solstices as well as spring equinox.

Thank you for your willingness to participate in this survey.

This survey is part of a PhD thesis at the Faculty of Architecture, Gdańsk University of Technology, titled *"The Impact of Daylighting on Library User Movement."* The aim of this questionnaire is to gather information about the space usage preferences of library users at the Mały Kack Library (specifically regarding user choice of seating, the user duration of stay in specific areas, and user movement patterns within the library).

The questionnaire consists of 32 questions that are multiple choices. The main goal of the PhD is to collect and analyze information on the perception of daylight conditions in the rooms of Tri-City libraries, as well as the associated patterns of preferences and movement within the building space.

Your input is invaluable to my research. The questionnaire should take approximately 8 to 14 minutes to complete. There are no right or wrong answers – I am interested in your personal experiences and opinions.

Please be assured that all responses will remain **anonymous and confidential.** No personal identifying information is collected, and the data will be used solely for research purposes. Your participation is completely voluntary, and you may withdraw at any time without any consequences.

If you have any questions or need further information regarding this research, please feel free to contact me:

Mosleh Ahmadi
PhD student, Faculty of Architecture
Gdansk University of Technology
Email address:
mosleh.ahmadi@pg.edu.pl

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Thank you.

Statistical information

Age: Under 12 ☐ 12-17 ☐ 18-29 ☐ 30-49 ☐ 50-64 ☐ 65 and above ☐

Gender: Male ☐ Female ☐ Non-binary ☐ Prefer not to say ☐

Occupation: Student ☐ Employed ☐ Unemployed ☐ Retired ☐

Figure 2.15. User questionnaire page 1.

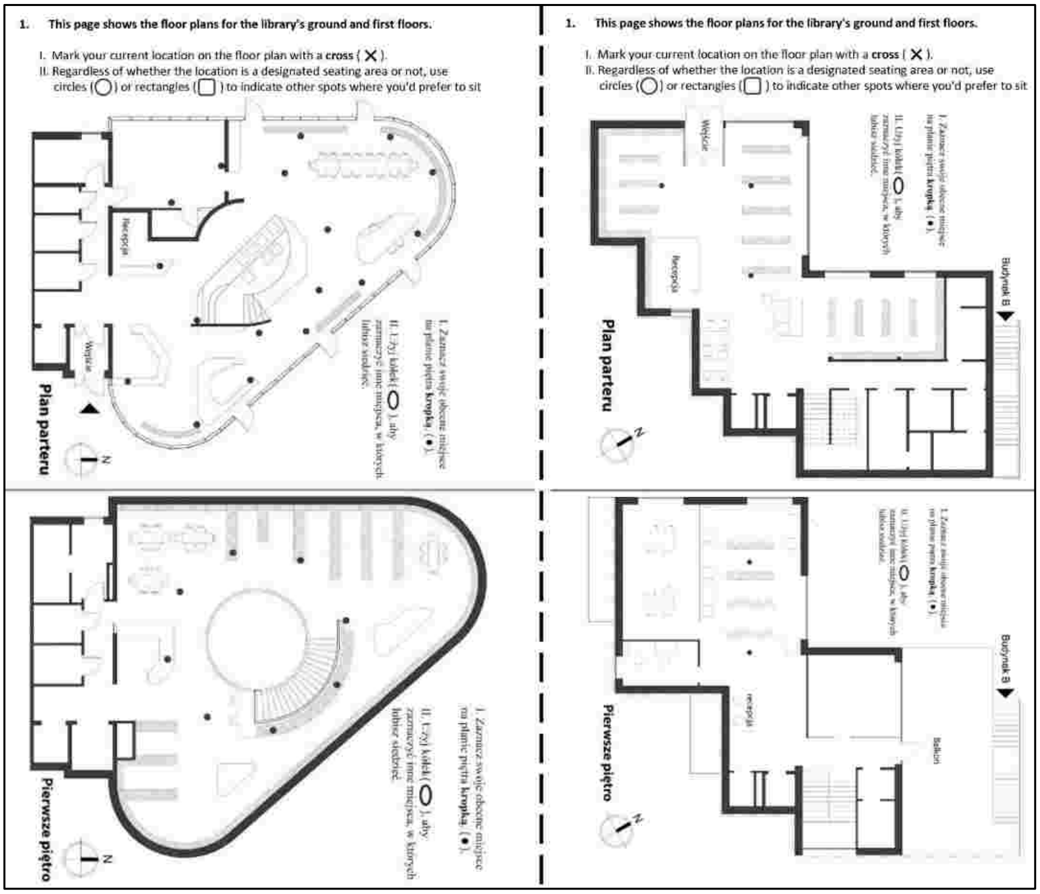


Figure 2.16. User questionnaire page 2 for Maly Kack library (left-hand side image) and Witomino library (right-hand side image).

2. **What is the motivation for you to choose this current location? (you can choose multiple options)**
   - Better daylighting condition ☐
   - Better electrical lighting condition ☐
   - Avoiding noise ☐
   - Privacy and isolation ☐
   - Comfortable seating ☐
   - View out ☐
   - Access to electricity or computer ☐
   - Access to books, shelves, or reception ☐

3. **What is the current type of sky?**
   - Clear sky (sunny) ☐
   - Partly cloudy sky ☐
   - Overcast sky (completely cloudy) ☐

4. **What is the current date and time?**

   Date: 2024/……./……….

   Time ………………………

5. **What is the lighting condition like in your location right now?**
   - Only natural daylight ☐
   - A mix of daylight and artificial lighting, with more natural daylight ☐
   - A mix of artificial lighting and daylight, with more artificial lighting ☐
   - Only artificial lighting ☐

6. **Do you have a window with a view from your seating area?**
   - Yes ☐
   - No ☐

7. **Are you satisfied with the view outside?**
   - Yes ☐
   - No ☐

Figure 2.17. User questionnaire page 3.

A) Movement questions:

8. Are you always sitting in this location?

- Yes ☐
- No ☐

9. How long have you been sitting or would you prefer to stay in your current seat?

- Less than half an hour ☐
- 45 minutes or more ☐
- Three hours ☐
- More than three hours ☐

Please explain why you chose that, in one word or sentence (Optional):

....

10. Which of these options best describes the atmosphere where you are sitting? (You can choose one or more)

- A stimulating environment ☐
- A calm space for taking a break ☐
- An open, social setting for conversation ☐
- A quiet, focused area for intense study ☐

11. What factors influence your choice to sit here?

1. Strongly agree	2. Agree	3. Neutral	4. Disagree	5. Strongly disagree

No.	Question	1	2	3	4	5
11.1	This spot was visible from the entrance	☐	☐	☐	☐	☐
11.2	This spot was close to the entrance	☐	☐	☐	☐	☐
11.3	This spot offered a clear view of the area around it	☐	☐	☐	☐	☐
11.4	This spot was near a main pathway	☐	☐	☐	☐	☐
11.5	This spot made it easy to interact with others	☐	☐	☐	☐	☐
11.6	This spot was close to natural light or a window	☐	☐	☐	☐	☐
11.7	This spot felt spacious and open	☐	☐	☐	☐	☐
11.8	This spot had a clear view from the window	☐	☐	☐	☐	☐
11.9	It was an easy and direct path to this spot	☐	☐	☐	☐	☐
11.10	This spot was quieter and had less foot traffic	☐	☐	☐	☐	☐

Figure 2.18. User questionnaire page 4.

B) Influence of Daylighting:

12. How important are these statements to your library experience?

1. Highly important	**2. Important**	**3. Neutral**	**4. Not important**	**5. Irrelevant**

No.	Question	1	2	3	4	5
12.1	Daylight is important	☐	☐	☐	☐	☐
12.2	I prefer to sit near windows or in areas with daylight	☐	☐	☐	☐	☐

13. How much do you agree with these statements about lighting and your attendance in the library?

6. Strongly agree	**7. Agree**	**8. Neutral**	**9. Disagree**	**10. Strongly disagree**

No.	Question	1	2	3	4	5
13.1	It's easier to focus in areas with good natural light	☐	☐	☐	☐	☐
13.2	I find seating and objects more appealing when the lights are dimmer	☐	☐	☐	☐	☐
13.3	Seeing outside through a window affects where I choose to sit	☐	☐	☐	☐	☐
13.4	Seeing outside through a window distracts me from my activity	☐	☐	☐	☐	☐

C) Library User Profile:

14. How often do you visit the library?

- Daily ☐
- Weekly ☐
- Monthly ☐
- Rarely ☐

Figure 2.19. User questionnaire page 5.

15. What do you usually do at the library? (Select all that apply)

- Study or read ☐
- Borrow books ☐
- Attend events, meetings, or workshops ☐
- Other (please specify): ☐

16. Which personality trait best describes you?

- Extraversion ☐
- Introversion ☐
- In between (ambiversion) ☐

17. What type of space do you choose for your activities in the library?

- Naturally lit space with direct sunlight ☐
- daylit space with artificial lighting ☐
- Artificially lit space without direct sunlight ☐

18. How do you usually use the library? (you can select multiple options)

- I know exactly what I want ☐
- I know what I need but am open to other options ☐
- I like to explore and discover new resources ☐
- I start with a topic and search for related materials ☐
- I explore sections of the library that interest me ☐
- I browse the library without a specific goal ☐

19. Is it important for you to notice the movement of other people around you while you're in the library?

- It makes me more likely to stay in the library ☐
- It makes me less likely to stay in the library ☐
- It does not have any effect ☐

Thank you very much for your participation!

Figure 2.20. User questionnaire page 6.

Justification of the Questions in the User Questionnaire

The questions in the user questionnaires were primarily according to the previous research in the literature of this study (Table 2.2). Other questions (question 11) were also stemmed from the space syntax notions in order to link and spot the subjective perception of space related to the parameters of space syntax such as connectivity and visibility. There are also questions according to the literature of libraries that could help to establish a user-perception-based profile for each point in the libraries (questions 2, 10, and 11).

Table 2.2. Sources of the Questions (Source: author)

Type of question	NO	Objectives	Source of Inspiration
Spatial configuration and location questions	1	These questions enable us to draw the behavior maps and connect them with the research questions derived from the literature review	Izmir Tunahan et al. (2022) Dubois et al. (2009)
	2		Abowardah et al. (2019)
	3	These questions are aimed at determining the environmental condition related to the lighting condition and its perception	Adapted from literature review on daylighting
	4		
	5		
	6		
	7		
User habit and spatial atmosphere	8	These questions are aimed to understand the user perception of the atmosphere and their habit of using that space	Peterson (2023)
	9		
	10		
Measurement scale questions on the spatial characteristic of the location	11	This question is consisted of 10 sub questions on the spatial integration, depth, visibility, and connectivity of the space	Adapted from the literature review on space syntax
Measurement scale questions on the importance of daylight	12.1	These questions are intended to understand the 'Preference for Natural Light' and the importance of daylight for the users and subsequently to analyze their movement pattern	Haans, A. (2014).
	12.2		Keskin et al. (2015)
Measurement scale questions on the daylight condition	13.1	This question is aiming to understand the relationship of daylight with cognitive engagement such as focus and concentration in browsing areas	Kilic & Hasirci (2011) Jamrozik et al. (2019)
	13.2	These questions are designed to assess the 'visual appeal' of library objects relative to daylight condition	Amundadottir et al. (2017)
	13.3		
	13.4	This question is aiming to understand the relationship of daylight with cognitive engagement such as focus and concentration in browsing areas	Kilic & Hasirci (2011)
	14	These questions are aimed at determining the type of library user regarding the	McKay (2019)
	15		

Library user type determination		frequency of attendance and motivation of presence at the library	
	16	This question is intended to include the relation of the type of personality trait with the lighting preference and movement behavior. this is important because it will help us to understand if the reason behind the choice is affected by the personal preference	Heydarian et al. (2017)
	17	This question is intended to help us to understand the psychological preference of users for daylight or artificial light, and it allows us to understand if daylit space with be attractive for all the users or not	Favero et al. (2023)
	18	This question helps to understand the reason behind choosing a specific location doing and a certain activity	McKay (2019)
	19	This question helps to understand the impact of the presence of other on the library user activity	Self-reflected

2.3.2. Librarian Observation Sheets and Questionnaire

The second set of questionnaires (Figs. 2.20, and 2.21) was designed to gather insights from librarians based on their own daily observations over a specific period (in Polish). Five copies of an observation sheet were printed and distributed to librarians, who were asked to complete them over at least three days in December, March, and June. Prior to data collection, librarians received training on how to accurately complete the sheets.

The purpose of using librarian-led observations was to minimize the observer effect, as the continuous presence of a researcher in the library could potentially influence user behavior. Each observation sheet included a floor plan with circles marking every seating area, allowing librarians to record quantitative data on the number of users and the duration of their stay. Additionally, the sheets captured movement trajectories, documenting how users relocated from one point to another within the library.

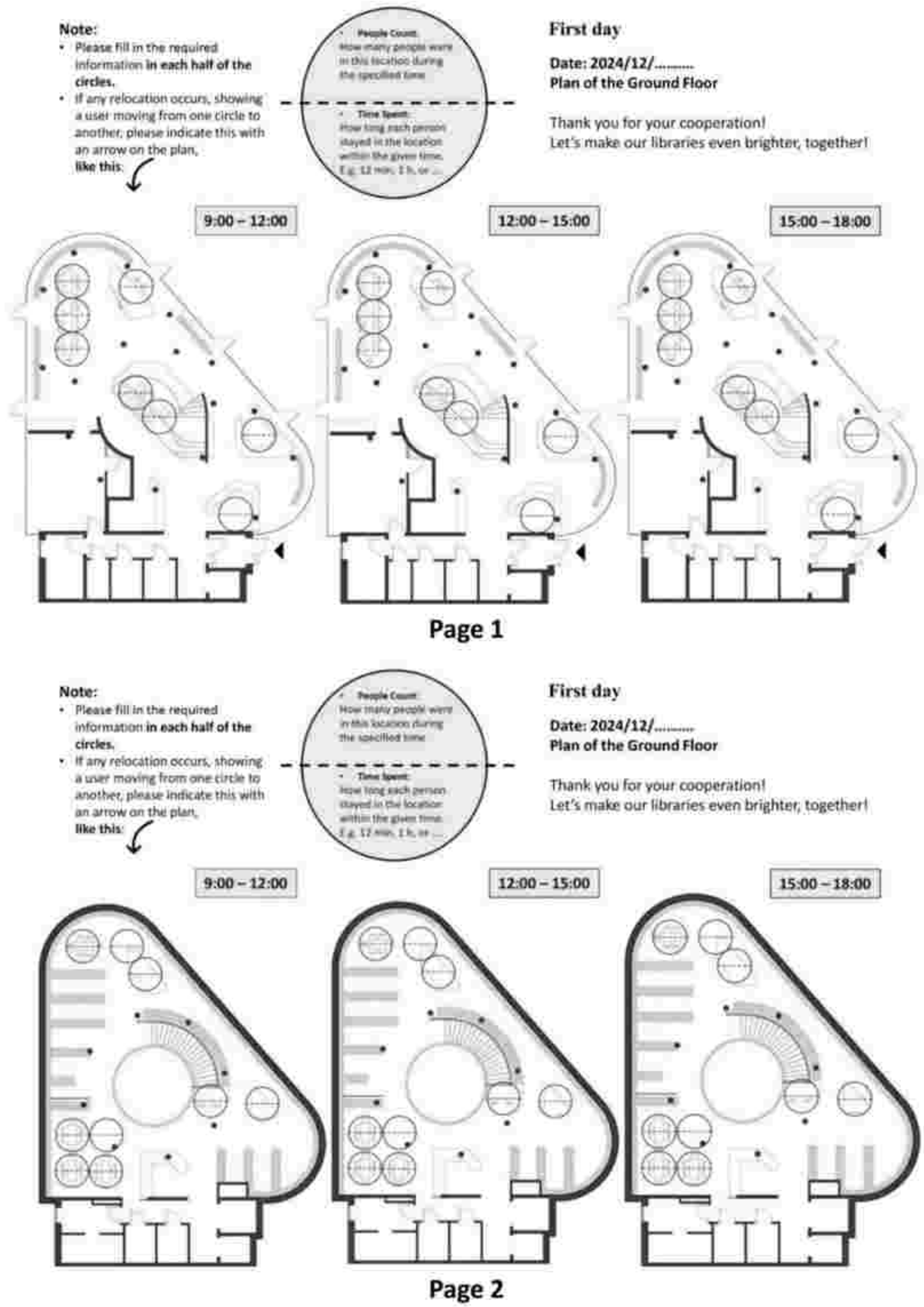


Figure 2.20. Observation sheets for Maly Kack library (Source: Author).

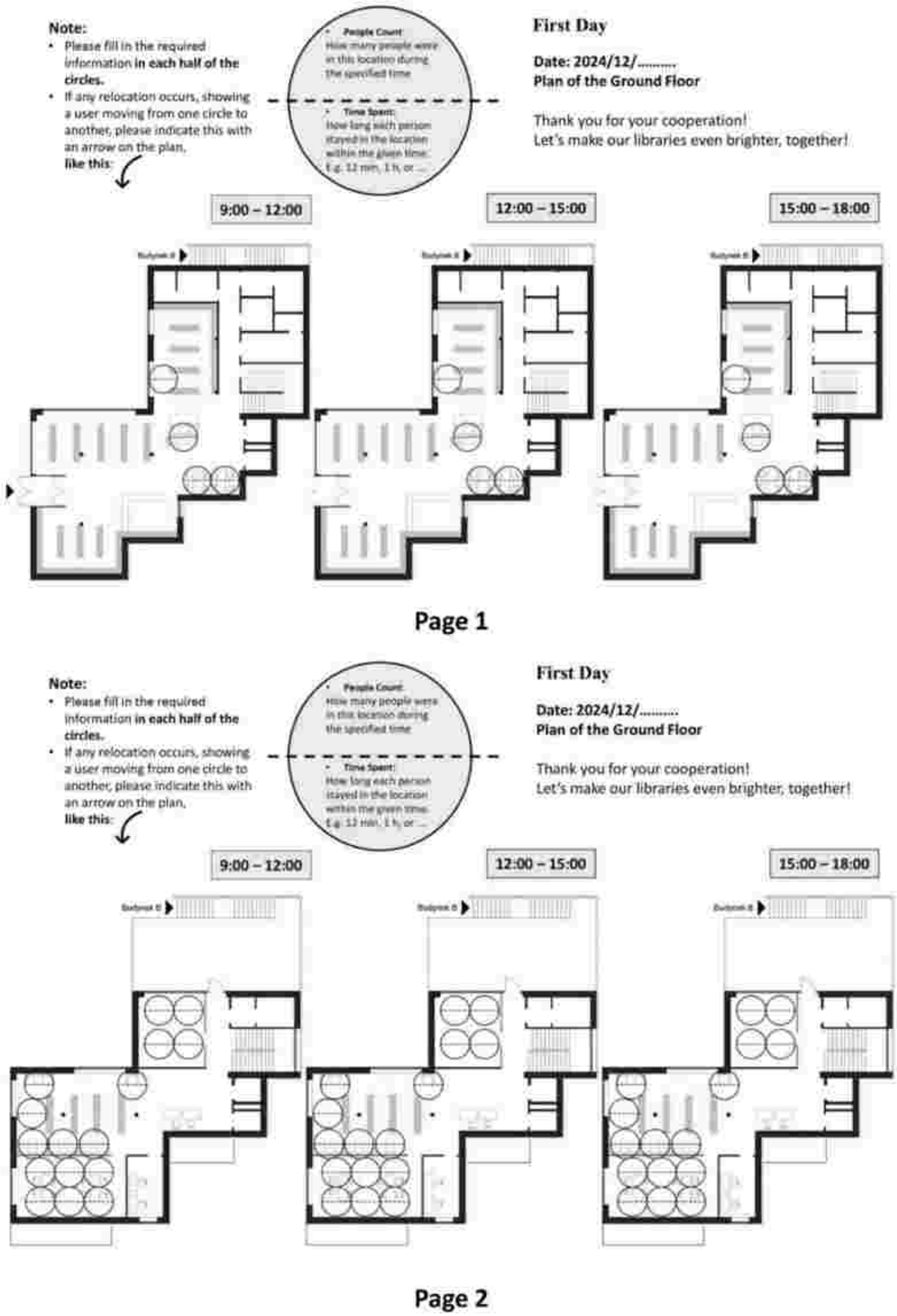


Figure 2.21. Observation sheets for Witomino library (Source: Author).

2.3.3. Researcher Observation Sheets

The third set of questionnaires were filled out during the researcher's on-site observations and measurements during one week of each month of December, March, and June in each library. This questionnaire was identical to the librarian questionnaire (Figs. 2.20, and 2.21).

2.4. User-Perceived Profiles of Library Spaces

Based on the initial results of the user questionnaires (refer to Appendix 3 – user questionnaire responses), which are compiled in an Excel spreadsheet - particularly responses to questions on seat selection (Question 2), preferred atmosphere (Question 10), and subjective assessments related to space syntax parameters (Question 11) - a perceptual profile of specific points within the libraries was developed. For ease of interpretation and representation, the questions have been categorized and labeled as shown below (Tables 2.3, and 2.4), to be used in the main profile tables (2.5, and 2.6).

The location of the respondents in the Excel sheet (Appendix 3) of the questionnaire responses was designated by numbers using points marked on the user questionnaire sheets by the respondents. These points corresponded to the seating locations where users completed the questionnaires. Accordingly, the seating positions were identified on the library floor plans and represented by circles for further analysis. These circles correspond directly to the seating points and areas used by respondents within the libraries. This resulted in 17 and 21 points in Maly Kack (Fig. 2.22) and Witomino (Fig. 2.23) libraries, respectively.

Table 2.3. Question 2 labeling and categorization (Source: author)

Choices from the Questionnaire	Label in the Profiles	Category in the profiles
Better daylighting condition	Better daylight	Lighting-Related Factors
Better electrical lighting condition	Better electric lighting	
View out	View outside	
Avoiding noise	Noise avoidance	Comfort-Related Factors
Privacy and isolation	Privacy and isolation	
Comfortable seating	Seat comfort	
Access to electricity or computer	Power/computer access	
Access to books, shelves, or reception	Access to books and resources	

Table 2.4. Question 11 labeling and categorization (Source: author)

Full statement from Questionnaire	Label in the Profiles	Category in the profiles
11.3 This spot offered a clear view of the area around it	Clear internal view	Lighting-Related Factors
11.6 This spot was close to natural light or a window	Abundance of natural light	
11.8 This spot had a clear view from the window	Good view out	
11.1 This spot was visible from the entrance	Visible from entrance	Movement-Related Factors
11.2 This spot was close to the entrance	Proximity to the entrance	
11.4 This spot was near a main pathway	Proximity to a main pathway	
11.9 It was an easy and direct path to this spot	Direct access	
11.5 This spot made it easy to interact with others	Easy social interaction	Environmental Factors
11.7 This spot felt spacious and open	Spacious/open space	
11.10 This spot was quieter and had less foot traffic	Quiet / less foot traffic	

This profile provides a useful reference for future hypothesis and architectural analysis as well as design considerations. Below the reference points and profile table for Maly Kack Library (Fig. 2.22) (Table 2.5) and Witomino library (Fig. 2.23) (Table 2.6) is presented.

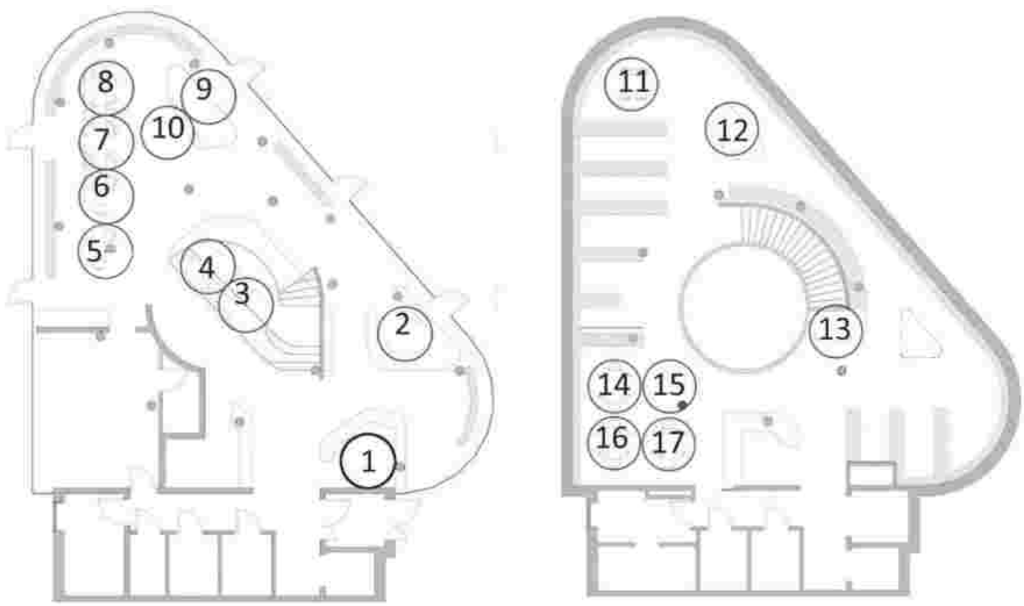


Figure 2.22. Reference points in Maly Kack library (Source: Author).

Table 2.5. Seating Profile of Maly Kack: User-Perceived Characteristics of Seating Places at Maly Kack Biblioteka (Based on Survey Responses) (Source: author)

Point NO	Environmental-Spatial Factors (Selected by ≥50%, from Multiple Choice Q2)	Atmosphere Type (Selected by ≥50%, from Multiple Choice Q10)	Choice Factors (Mean ≥ 3.5, from Likert Scale Q11)
1	***Lighting-Related Factors:*** • Better electric lighting ***Comfort-Related Factors:*** • Seat comfort • Power/computer access *(1 Response)*	• Stimulating environment *(1 Response)*	***Movement-Related Factors:*** • Near entrance • Proximity to a main pathway ***Environmental Factors:*** • Easy social interaction • Direct access • Quiet / less foot traffic *(1 Response)*
2	***Comfort-Related Factors:*** • Privacy and isolation *(6 Responses)*	• A calm space for taking a break *(6 Responses)*	***Lighting-Related Factors:*** • Clear internal view ***Movement-Related Factors:*** • Proximity to a main pathway ***Environmental Factors:*** • Quiet / less foot traffic *(6 Responses)*
3	***Comfort-Related Factors:***	• A calm space for taking a break	***Lighting-Related Factors:***

	• Seat comfort • Access to books and resources *(8 Responses)*	*(8 Responses)*	• Clear view out • Abundance of natural light • Clear internal view ***Movement-Related Factors:*** • Visible from entrance • Proximity to the entrance • Proximity to a main pathway • Direct access ***Environmental Factors:*** • Easy social interaction • Spacious/open space *(8 Responses)*
4	***Comfort-Related Factors:*** • Power/computer access *(4 Responses)*	• An open, social setting for conversation *(4 Responses)*	***Lighting-Related Factors:*** • Abundance of natural light • Clear internal view ***Movement-Related Factors:*** • Visible from entrance • Proximity to the entrance • Proximity to a main pathway • Direct access ***Environmental Factors:*** • Easy social interaction • Spacious/open space *(4 Responses)*
5	***Lighting-Related Factors:*** • Better daylight • View outside *(10 Responses)*	• An open, social setting for conversation *(10 Responses)*	***Lighting-Related Factors:*** • Abundance of natural light • Clear view out • Clear internal view ***Movement-Related Factors:*** • Visible from entrance • Proximity to a main pathway • Direct access ***Environmental Factors:*** • Easy social interaction • Spacious/open space *(10 Responses)*

6	***Comfort-Related Factors:*** • Access to books and resources *(9 Responses)*	No dominant attribute was identified *(9 Responses)*	***Lighting-Related Factors:*** • Abundance of natural light • Clear view out • Clear internal view ***Movement-Related Factors:*** • Visible from entrance • Proximity to a main pathway • Direct access ***Environmental Factors:*** • Easy social interaction • Spacious/open space *(9 Responses)*
7	***Lighting-Related Factors:*** • View outside *(6 Responses)*	No dominant attribute was identified *(6 Responses)*	***Lighting-Related Factors:*** • Abundance of natural light • Clear internal view • Clear view out ***Movement-Related Factors:*** • Direct access • Proximity to a main pathway • Easy social interaction ***Environmental Factors:*** • Spacious/open space *(6 Responses)*
8	***Comfort-Related Factors:*** • Access to books and resources *(6 Responses)*	No dominant attribute was identified *(6 Responses)*	***Lighting-Related Factors:*** • Abundance of natural light • Clear internal view • Clear view out ***Movement-Related Factors:*** • Proximity to a main pathway • Direct access ***Environmental Factors:*** • Spacious/open space • Quiet / less foot traffic *(6 Responses)*
9	***Comfort-Related Factors:*** • Privacy and isolation	• A quiet, focused area for intense study	***Lighting-Related Factors:*** • Abundance of natural light

	(3 Responses)	*(3 Responses)*	• Clear view out ***Movement-Related Factors:*** • Direct access ***Environmental Factors:*** • Spacious/open space • Quiet / less foot traffic *(3 Responses)*
<u>10</u>	***Comfort-Related Factors:*** • Privacy and isolation • Power/computer access *(1 Response)*	• A quiet, focused area for intense study *(1 Response)*	***Lighting-Related Factors:*** • Abundance of natural light • Clear view out ***Movement-Related Factors:*** • Direct access ***Environmental Factors:*** • Quiet / less foot traffic *(1 Response)*
<u>11</u>	***Comfort-Related Factors:*** • Noise avoidance • Privacy and isolation • Seat comfort *(11 Responses)*	• A calm space for taking a break • A quiet, focused area for intense study *(11 Responses)*	***Environmental Factors:*** • Quiet / less foot traffic *(11 Responses)*
<u>12</u>	***Lighting-Related Factors:*** • Better daylight ***Comfort-Related Factors:*** • Noise avoidance • Privacy and isolation • Seat comfort • Access to books and resources *(4 Responses)*	• A calm space for taking a break • An open, social setting for conversation *(4 Responses)*	***Lighting-Related Factors:*** • Abundance of natural light • Clear internal view ***Movement-Related Factors:*** • Visible from entrance • Proximity to the entrance • Proximity to a main pathway • Direct access ***Environmental Factors:*** • Spacious/open space *(4 Responses)*
<u>13</u>	***Lighting-Related Factors:*** • Better daylight ***Comfort-Related Factors:*** • Seat comfort • Power/computer access *(2 Responses)*	• A calm space for taking a break • A quiet, focused area for intense study *(2 Responses)*	***Environmental Factors:*** • Quiet / less foot traffic *(2 Responses)*

14	***Comfort-Related Factors:*** • Privacy and isolation *(9 Responses)*	• A quiet, focused area for intense study *(9 Responses)*	***Environmental Factors:*** • Quiet / less foot traffic *(9 Responses)*
15	***Lighting-Related Factors:*** • Better electric lighting ***Comfort-Related Factors:*** • Noise avoidance • Privacy and isolation • Seat comfort • Access to books and resources *(2 Responses)*	• A quiet, focused area for intense study • A calm space for taking a break *(2 Responses)*	***Lighting-Related Factors:*** • Clear internal view ***Movement-Related Factors:*** • Proximity to a main pathway • Direct access ***Environmental Factors:*** • Spacious/open space • Quiet / less foot traffic *(4 Responses)*
16	***Comfort-Related Factors:*** • Privacy and isolation • Seat comfort • Access to books and resources *(3 Responses)*	• A quiet, focused area for intense study *(3 Responses)*	***Lighting-Related Factors:*** • Clear internal view ***Movement-Related Factors:*** • Proximity to a main pathway • Direct access ***Environmental Factors:*** • Spacious/open space • Quiet / less foot traffic *(3 Responses)*
17	***Lighting-Related Factors:*** • Better daylight ***Comfort-Related Factors:*** • Privacy and isolation • Seat comfort *(4 Responses)*	• A quiet, focused area for intense study *(4 Responses)*	***Lighting-Related Factors:*** • xxxxxxx ***Movement-Related Factors:*** • Direct access ***Environmental Factors:*** • Easy social interaction • Spacious/open space • Quiet / less foot traffic *(4 Responses)*

Figure 2.23. Reference points in Maly Kack library (Source: Author).

Table 2.6. Seating Profile of Witomino: User-Perceived Characteristics of Seating Places at Witomino Biblioteka (Based on Survey Responses) (Source: author)

Point NO	Environmental-Spatial Factors (Selected by ≥50%, from Multiple Choice Q2)	Atmosphere Type (Selected by ≥50%, from Multiple Choice Q10)	Choice Factors (Mean ≥ 3.5, from Likert Scale Q11)
1	***Lighting-Related Factors:*** • Better daylight • Better electric lighting ***Comfort-Related Factors:*** • Seat comfort *(4 Responses)*	• A calm space for taking a break *(4 Responses)*	***Lighting-Related Factors:*** • Abundance of natural light ***Movement-Related Factors:*** • Visible from entrance • Near entrance • Proximity to a main pathway ***Environmental Factors:*** • Easy social interaction • Spacious/open space • Direct access • Quiet / less foot traffic *(4 Responses)*
2	***Lighting-Related Factors:*** • Better daylight • View outside ***Comfort-Related Factors:*** • Access to books and resources *(1 Response)*	• A calm space for taking a break *(1 Response)*	***Lighting-Related Factors:*** • Clear internal view • Abundance of natural light • Good view out ***Movement-Related Factors:*** • Proximity to a main pathway ***Environmental Factors:*** • Spacious/open space • Direct access

			(1 Response)
3	***Lighting-Related Factors:*** • Better daylight ***Comfort-Related Factors:*** • Noise avoidance • Power/computer access *(2 Responses)*	• A quiet, focused area for intense study *(2 Responses)*	***Lighting-Related Factors:*** • Clear internal view ***Movement-Related Factors:*** • Visible from entrance • Proximity to the entrance ***Environmental Factors:*** • Easy social interaction • Spacious/open space • Quiet / less foot traffic *(2 Responses)*
4	***Lighting-Related Factors:*** • Better daylight • Better electric lighting ***Comfort-Related Factors:*** • Privacy and isolation • Seat comfort • Power/computer access *(2 Responses)*	No dominant attribute was identified *(2 Responses)*	***Lighting-Related Factors:*** • Clear internal view ***Movement-Related Factors:*** • Visible from entrance • Proximity to the entrance • Proximity to a main pathway • Direct access *(2 Responses)*
5	Roughly similar to the point 8. Points 6, 7, 8, and 9 are located in the same room (so-called The Aquarium). *(No Response)*	Roughly similar to the point 8. Points 6, 7, 8, and 9 are located in the same room (so-called The Aquarium). *(No Response)*	Roughly similar to the point 8. Points 6, 7, 8, and 9 are located in the same room (so-called The Aquarium). *(No Response)*
6	Roughly similar to the point 8. Points 6, 7, 8, and 9 are located in the same room (so-called The Aquarium). *(No Response)*	Roughly similar to the point 8. Points 6, 7, 8, and 9 are located in the same room (so-called The Aquarium). *(No Response)*	Roughly similar to the point 8. Points 6, 7, 8, and 9 are located in the same room (so-called The Aquarium). *(No Response)*
7	Roughly similar to the point 8. Points 6, 7, 8, and 9 are located in the same room (so-called The Aquarium). *(No Response)*	Roughly similar to the point 8. Points 6, 7, 8, and 9 are located in the same room (so-called The Aquarium). *(No Response)*	Roughly similar to the point 8. Points 6, 7, 8, and 9 are located in the same room (so-called The Aquarium). *(No Response)*
8	***Lighting-Related Factors:*** • Better daylight	• A stimulating environment	***Lighting-Related Factors:*** • Clear internal view

	Comfort-Related Factors: • Access to books and resources *(2 Responses)*	*(2 Responses)*	• Abundance of natural light • Good view out ***Movement-Related Factors:*** • Proximity to a main pathway • Direct access ***Environmental Factors:*** • Easy social interaction • Spacious/open space *(2 Responses)*
9	***Comfort-Related Factors:*** • Noise avoidance • Seat comfort *(1 Response)*	• A calm space for taking a break *(1 Response)*	***Lighting-Related Factors:*** • Abundance of natural light ***Movement-Related Factors:*** • Visible from entrance • Proximity to the entrance • Proximity to a main pathway • Direct access ***Environmental Factors:*** • Spacious/open space *(1 Response)*
10	***Lighting-Related Factors:*** • Better daylight • View outside ***Comfort-Related Factors:*** • Seat comfort *(3 Responses)*	• A calm space for taking a break *(3 Responses)*	***Lighting-Related Factors:*** • Abundance of natural light • Clear internal view • Good view out ***Movement-Related Factors:*** • Proximity to the entrance • Proximity to a main pathway • Direct access ***Environmental Factors:*** • Spacious/open space *(3 Responses)*
11	***Lighting-Related Factors:*** • Better daylight • Better electric lighting • View outside ***Comfort-Related Factors:*** • Seat comfort *(2 Responses)*	• A calm space for taking a break *(2 Responses)*	***Lighting-Related Factors:*** • Clear internal view • Abundance of natural light • Good view out ***Movement-Related Factors:*** • Visible from entrance • Proximity to a main pathway • Direct access ***Environmental Factors:*** • Spacious/open space • Quiet / less foot traffic *(2 Responses)*
12	***Lighting-Related Factors:*** • Better daylight • View outside	• A calm space for taking a break	***Lighting-Related Factors:*** • Clear internal view • Abundance of natural light

	Comfort-Related Factors: • Privacy and isolation • Seat comfort *(3 Responses)*	*(3 Responses)*	• Good view out ***Movement-Related Factors:*** • Proximity to a main pathway • Direct access ***Environmental Factors:*** • Spacious/open space • Quiet / less foot traffic *(3 Responses)*
13	***Lighting-Related Factors:*** • Better daylight • Better electric lighting ***Comfort-Related Factors:*** • Privacy and isolation • Seat comfort *(1 Response)*	• A calm space for taking a break *(1 Response)*	***Movement-Related Factors:*** • Direct access ***Environmental Factors:*** • Quiet / less foot traffic *(1 Response)*
14	Similar to the point 15. Points 14, and 15 are located at the same seat. *(No Response)*	Similar to the point 15. Points 14, and 15 are located at the same seat. *(No Response)*	Similar to the point 15. Points 14, and 15 are located at the same seat. *(No Response)*
15	***Lighting-Related Factors:*** • Better daylight • Better electric lighting *(1 Response)*	• An open, social setting for conversation *(1 Response)*	***Lighting-Related Factors:*** • Clear internal view • Abundance of natural light • Good view out ***Movement-Related Factors:*** • Visible from entrance • Proximity to the entrance • Proximity to a main pathway • Direct access ***Environmental Factors:*** • Easy social interaction • Spacious/open space • Quiet / less foot traffic *(1 Response)*
16	Roughly similar to the points 20 and 21. Points 16, 17, 18, 19, 20, and 21 are located in the same room (Multifunctional room). *(No Response)*	Roughly similar to the points 20 and 21. Points 16, 17, 18, 19, 20, and 21 are located in the same room (Multifunctional room). *(No Response)*	Roughly similar to the points 20 and 21. Points 16, 17, 18, 19, 20, and 21 are located in the same room (Multifunctional room). *(No Response)*
17	Roughly similar to the points 20 and 21. Points	Roughly similar to the points 20 and 21.	Roughly similar to the points 20 and 21. Points 16, 17, 18, 19,

	16, 17, 18, 19, 20, and 21 are located in the same room (Multifunctional room). *(No Response)*	Points 16, 17, 18, 19, 20, and 21 are located in the same room (Multifunctional room). *(No Response)*	20, and 21 are located in the same room (Multifunctional room). *(No Response)*
18	Roughly similar to the points 20 and 21. Points 16, 17, 18, 19, 20, and 21 are located in the same room (Multifunctional room). *(No Response)*	Roughly similar to the points 20 and 21. Points 16, 17, 18, 19, 20, and 21 are located in the same room (Multifunctional room). *(No Response)*	Roughly similar to the points 20 and 21. Points 16, 17, 18, 19, 20, and 21 are located in the same room (Multifunctional room). *(No Response)*
19	Roughly similar to the points 20 and 21. Points 16, 17, 18, 19, 20, and 21 are located in the same room (Multifunctional room). *(No Response)*	Roughly similar to the points 20 and 21. Points 16, 17, 18, 19, 20, and 21 are located in the same room (Multifunctional room). *(No Response)*	Roughly similar to the points 20 and 21. Points 16, 17, 18, 19, 20, and 21 are located in the same room (Multifunctional room). *(No Response)*
20	***Comfort-Related Factors:*** • Noise avoidance • Seat comfort • Power/computer access *(3 Responses)*	• A calm space for taking a break • A quiet, focused area for intense study *(3 Responses)*	***Lighting-Related Factors:*** • Abundance of natural light • Good view out ***Movement-Related Factors:*** • Visible from entrance • Proximity to the entrance • Direct access ***Environmental Factors:*** • Spacious/open space • Quiet / less foot traffic *(3 Responses)*
21	***Lighting-Related Factors:*** • Better daylight ***Comfort-Related Factors:*** • Noise avoidance • Privacy and isolation • Power/computer access *(4 Responses)*	• A quiet, focused area for intense study *(4 Responses)*	***Lighting-Related Factors:*** • Abundance of natural light • Good view out ***Movement-Related Factors:*** • Direct access ***Environmental Factors:*** • Spacious/open space • Quiet / less foot traffic *(4 Responses)*

It is noteworthy that when aggregating the reasons behind seating point selection (according to the question 2 in the user questionnaires), better daylighting and better lighting conditions were not identified as the top priorities by most respondents. Instead, factors such as comfortable seating, privacy, and a sense of isolation emerged as the dominant motivations for seat choice. An exception was observed in Witomino during June, where better daylighting conditions were cited as the primary reason for selecting a seat. Another significant factor influencing user decisions was the desire to avoid noise, as illustrated in Figures 2.24 and 2.25.

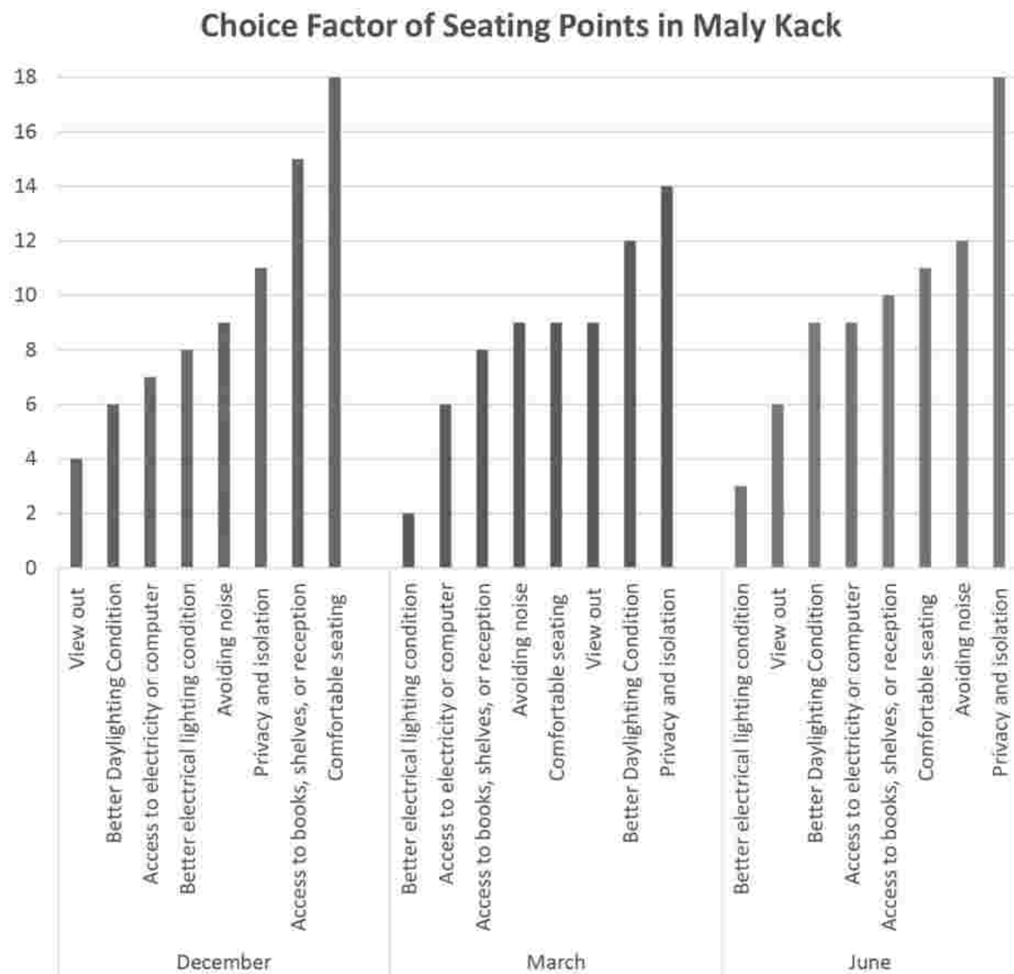


Figure 2.24. Choice factor in Maly Kack among 89 respondents (source: author).

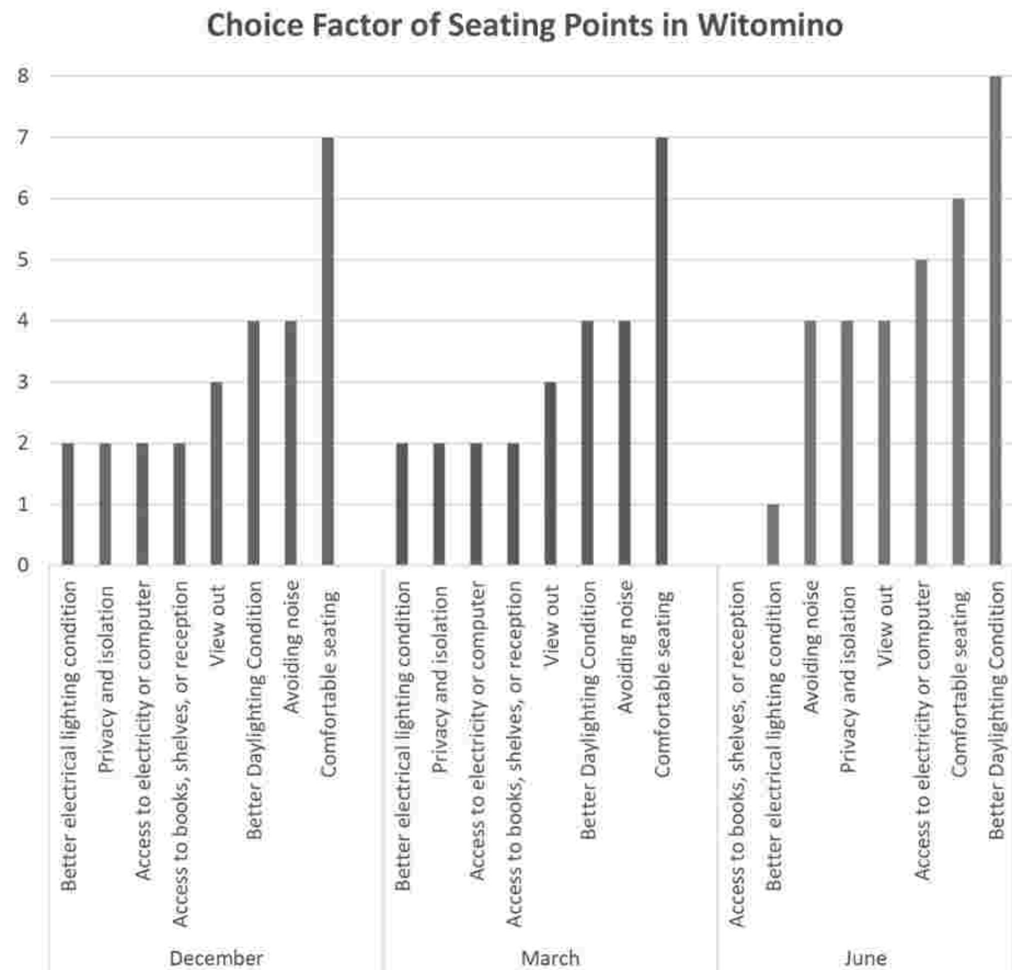


Figure 2.25. Choice factor in Witomino among 29 respondents (source: author).

2.4.1. Seating Preferences

One of the other questions in the user questionnaire that contributes to a deeper understanding of seat preferences - and enriches the seating profiles for Maly Kack and Witomino (as shown in Tables 2.5 and 2.6) - is Question 1. In this question, respondents were asked to mark the exact location of their current seat with a cross and to indicate any additional preferred seating locations using circles. The figures below present the combined results, showing all user-marked circles overlaid onto a single sheet, effectively visualizing perceived desirable seating areas (see Figures 2.26 and 2.28).

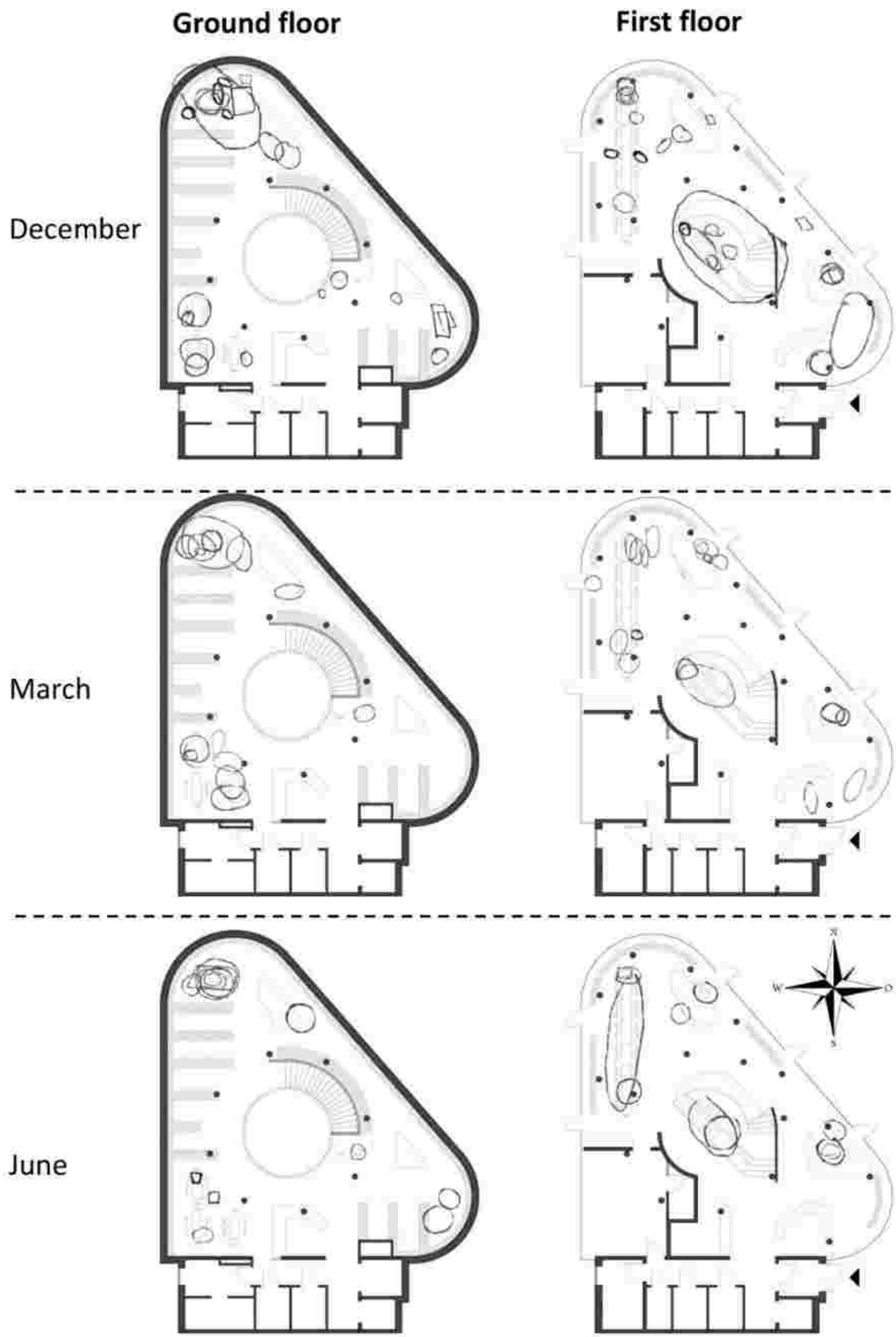


Figure 2.26. Seat preferences in Maly Kack library (source: author).

Based on Question 1 from the user questionnaire, a graph for each library was created to visualize both the current and additional favorite seating points (refer to Figures 2.27, and 2.29). This graph reflects seating preferences reported by users who were already seated in what they considered their preferred location. In addition to marking their current seat, each respondent also indicated other locations they found desirable. By comparing the frequency of current seating selections with additional favorite points, the graph highlights which seating areas are consistently preferred and which are perceived as secondary or alternative choices. This comparison helps to identify clusters of high desirability and provides insight into the perceived spatial quality of seating zones beyond their immediate use.

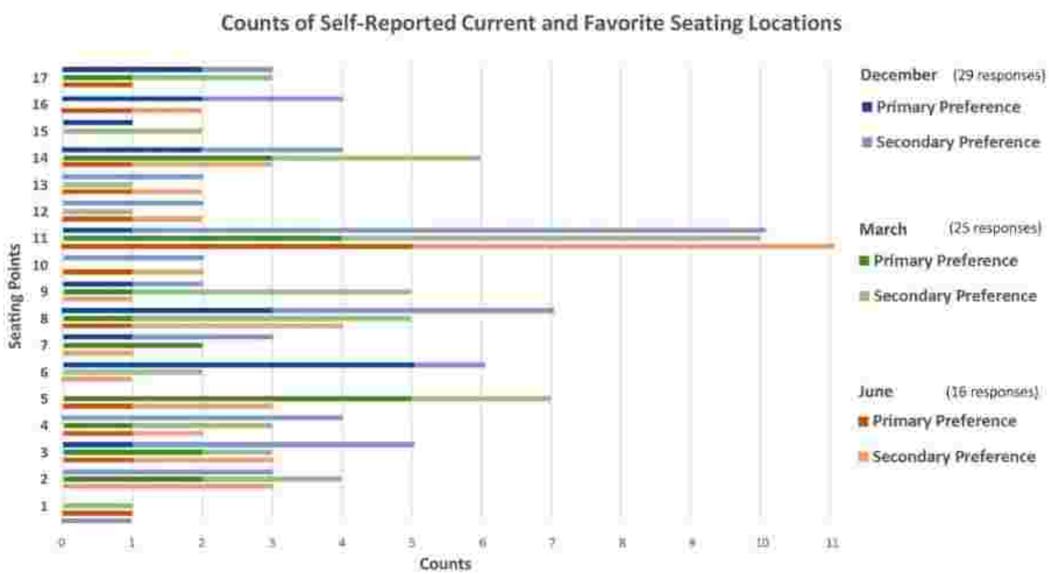


Figure 2.27. Comparison of current and additional favorite seating preferences by users in Maly Kack library.

According to the respondents, several seating points in the Maly Kack library show a gradual decline in preference—both as primary and secondary choices—across the months from December to June. These include points 17, 16, 4, 6, 7, and 8, which appear to be less favored as daylight conditions improve. Notably, Point 15 was selected as a primary preferred seat only in December, while in March, it was indicated solely as a secondary (perceived) preference. A similar pattern is observed with Point 6, which was used as a primary seat in December, but was only marked as a secondary preference in March and June. Interestingly, point 11 demonstrates a consistent overall level of preference across all three months, but with a gradual increase in primary preference from the low-daylight season to the high-daylight season. In fact, Point 11 emerges as the most preferred seating location overall. It was the most frequently selected primary seat in June, followed by Point 5 in March, and Point 6 in December.

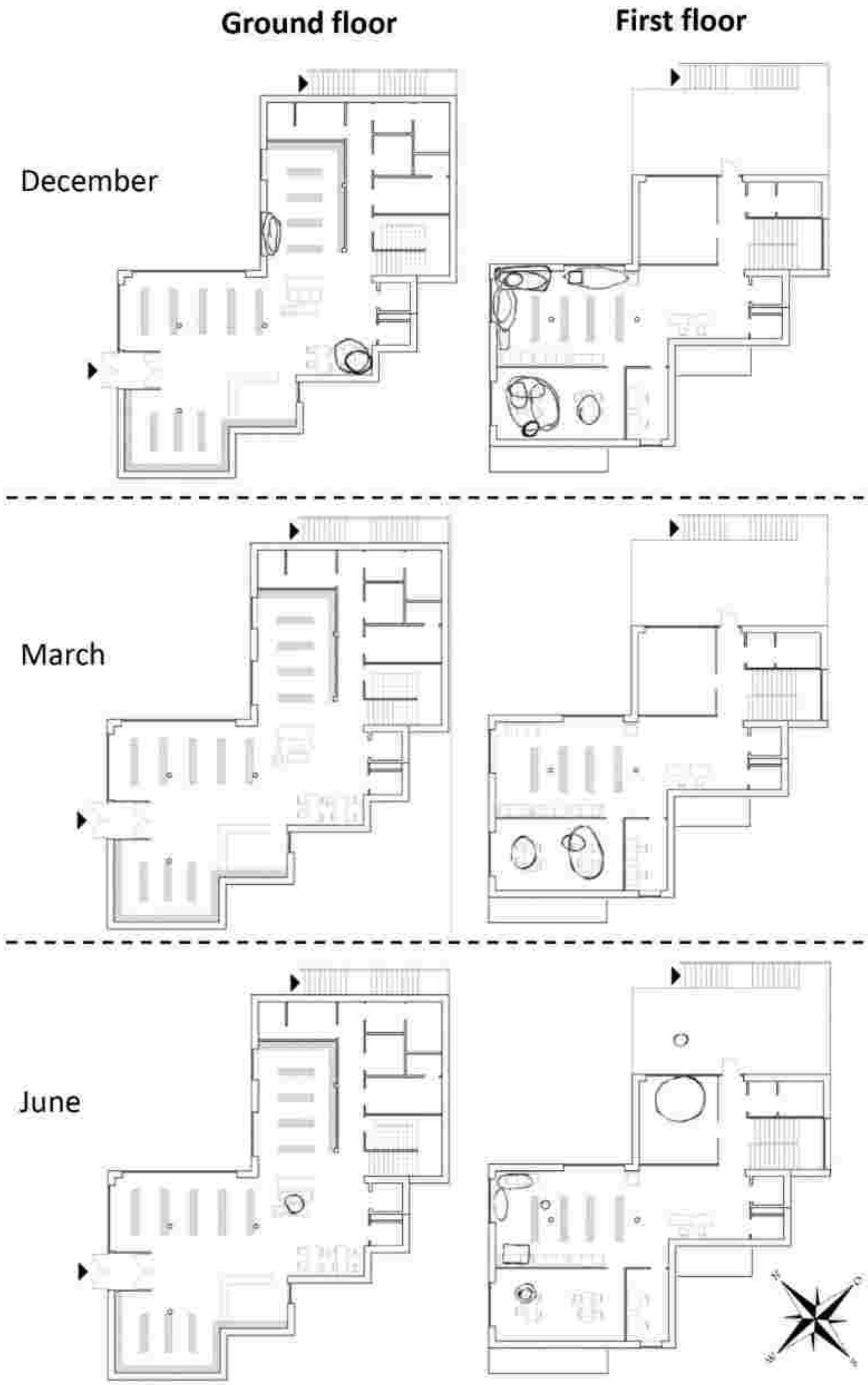


Figure 2.28. Seat preferences in Maly Kack library (source: author).

According to the respondents in the Witomino library, Point 2 was selected as both a primary and secondary preferred seating location only in December, and did not appear among the preferred choices in other seasons. Seating Points 6 and 14 were not selected in any season, suggesting a consistently low level of preference. A cluster of seating points - 16, 17, 18, 19, 20, and 21 - are located in the same room and are furnished with similar seating types. Within this group, Points 16 to 19 were chosen exclusively as secondary preferences and were not selected as primary seating points at any time. Moreover, these points were not selected at all during June, indicating a decrease in their appeal during the brighter months. In contrast, Points 20 and 21, which are the closest to the window in this room, were identified as highly preferred seats, being selected consistently as both primary and secondary choices. Seasonal patterns in seating preferences are also evident. In December, Points 20 and 11 were the most preferred seating locations. By March, preferences shifted slightly toward Points 1 and 21. In June, Points 12 and 20 emerged as the most frequently chosen seating points, reflecting possible changes in users' spatial preferences across different lighting and seasonal conditions.

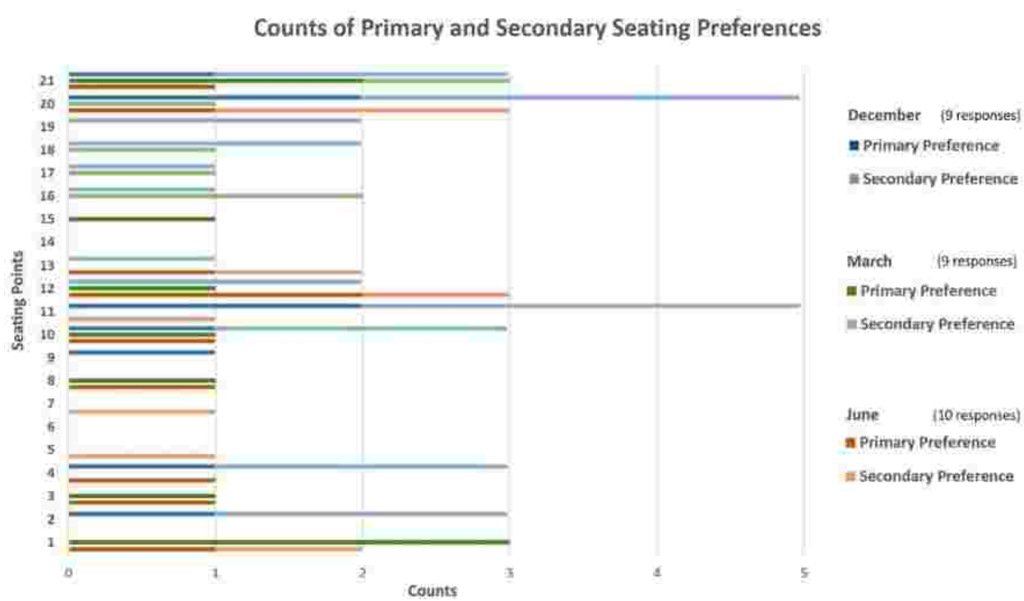


Figure 2.29. Comparison of current and additional favorite seating preferences by users in Witomino library (source: author).

Chapter Three

Modeling and Simulations

In the previous chapter, the research design and survey methodology were thoroughly outlined, and key findings from the user questionnaire were presented through two tables. These tables captured the user-perception-based (subjective) profiles of individual seating points - 17 in the Maly Kack library and 21 in the Witomino library.

This chapter shifts the focus to the modeling and simulation of daylighting conditions and space syntax parameters within the library environments. These simulations aim to generate objective profiles of the seating points, offering a data-driven foundation for future architectural analysis and design decisions.

The chapter is divided into two main sections. The first details the evaluation of daylighting in the buildings using the AnuuOWL plug-in for Rhino, including the daylight simulation workflow. The second section focuses on the collection and processing of spatial configuration data using DepthmapX for space syntax analysis. Data retrieved from both software tools are then processed, organized, and visualized using Excel for further interpretation.

3.1. Objective Data Collection and Analysis of Daylighting Condition

As mentioned earlier, there are various ways to evaluate daylighting in the buildings. In the first decade of the 21st century, HDR photography proved to be a reliable and efficient tool for capturing luminance across a broad range of values, with an average accuracy of around 10% (Inanici, 2006). This technique offers high-resolution luminance data over large fields of view, making it cost-effective and accessible to lighting practitioners and researchers. A notable study by Jørgensen et al. (2012) applied HDR photography in three libraries in Copenhagen to assess perceived luminance in two modes: lights on and lights off.

As a part of initial daylighting evaluation in the libraries, a site visit focused on capturing a comprehensive photographic record of the libraries' interiors. The selection of camera positions and view angles was guided by two key considerations:

- **Corridors for Movement:** Locations that functioned as main circulation paths were prioritized, as they reflect the flow of movement through the space.
- **Coverage of Interior Elements:** View angles were chosen to maximize the coverage of critical elements such as seating areas, tables, bookshelves,

daylighting elements (e.g., windows), floors, walls, and the ceiling. The aim was to capture a representative view of each area to support future analysis.

Photographs were taken primarily on the first floor of the library for several reasons:

- **Control of Artificial Lighting**: The ability to switch artificial lighting on and off made it possible to isolate and document natural daylight availability at specific points in time.
- **Concentration of Seating Areas**: The majority of seating locations are situated on the first floor, which made it a logical focus area for the study. Only a limited number of seating areas designated for online browsing and communication are located on the ground floor, which was less critical for the analysis. However, this does not mean that the connection of the ground floor with the first floor will be neglected in the analysis.

After reviewing over 100 photographs taken from various locations and angles, a selection of 8 key locations for the first floor and 2 key locations for the ground floor for the camera was made for Witomino Library. Since there are limited seating points in the ground floor of this library, the locations for taking photographs on this floor were limited to only two key points. The pictures taken in Maly Kack were approximately 130 photographs out of which 4 key locations for the ground floor and 3 key locations for the first floor were selected. These locations were chosen based on their representativeness and suitability for establishing stable camera positions for future analysis (Fig. 3.1). The criteria for selection included:

- The coverage of major elements within the space.
- The positioning of the camera in relation to seating areas and daylighting elements.
- The ability to consistently capture lighting conditions for further HDR photography.

Figure 3.1. The setting for the HDR photography included readings of the illuminance level at the height of the camera lens (Pictures by author).

The images at each location were taken with ISO 200, f/5.6, and three different shutter speeds of 1/15. 1/60, and 1/125. Photoshop software then was used to integrate these three images into one HDR image for each scene (Fig. 3.2).

Figure 3.2. Workflow of the generation of HDR pictures (source: author).

After running the false-color analysis in grasshopper ladybug tool based on the HDR images, it was found that the legend for the false color could not be generated. To resolve this issue, a Python script was used, incorporating the standard luminance calculation formula. The script analyzed luminance based on pixel data and RGB values, allowing for effective processing of the image in batches (Fig. 3.3). Nonetheless, the generated legend remained at the same threshold for all of the images.

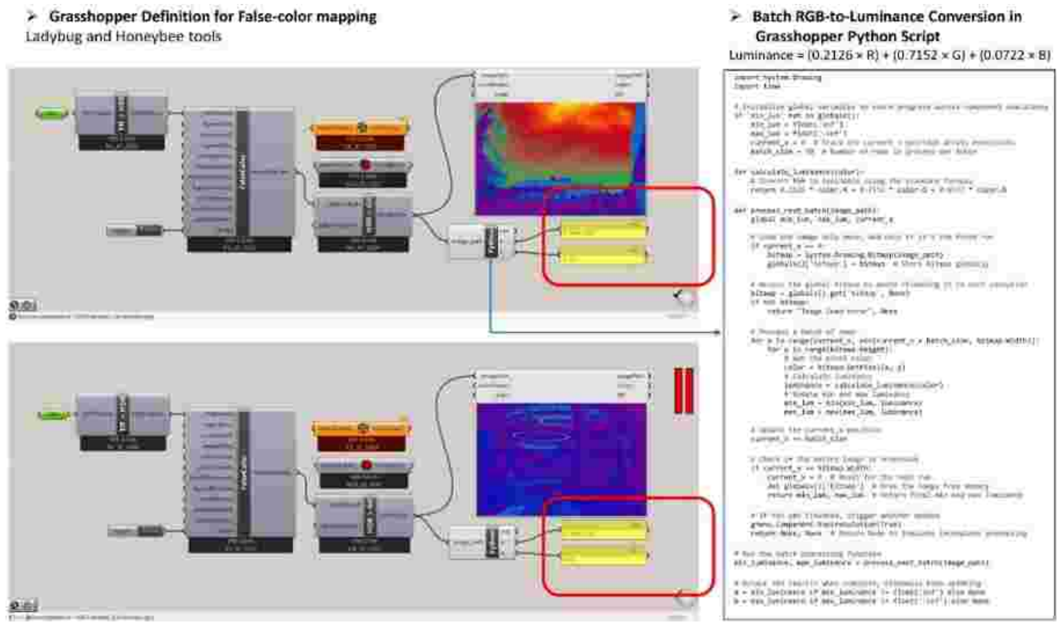


Figure 3.3. The workflow of generating false color image with accurate legend according to the pixels of the image taken (source: author).

The legend threshold (maximum luminance) consistently remained at 238.237 cd/m² for all analyzed images, according to the definition in Grasshopper. This method failed to generate an appropriate legend, and as a result, it was only used for qualitative analysis of perceived luminance in the scenes.

Luminance HDR version 2.6.0 was also used to generate an HDR image from three different exposures to assess the credibility of the results. However, after running the false-color image component, the legend remained fixed at the same threshold. Considering these limitations, along with the fact that the method is now outdated, it is best suited for qualitative analysis based on observation rather than in-depth quantitative daylight analysis. The tool can still be useful for comparing the perceived brightness of different scenes, particularly in scenarios with and without artificial lighting.

To illustrate the minimum daylight entering the space throughout the year, a single scene from each library is analyzed as an example. These scenes, captured at first floors of both of the libraries next to their circulation desks, depict conditions with lights both on and off. For the Witomino Library, the photographs were taken on two separate mornings in December and are shown in Figure (Fig. 3.4). In the case of the Mały Kack Library, two sets of images captured on the same day - one in the morning and another in the afternoon - are presented in Figure (Fig. 3.5) to demonstrate the variability within a single day.

Figure 3.4. False color images showing the luminance difference in the Witomino (first floor) (source: author).

While HDR imaging has proven reliable for real-time, qualitative lighting analysis - particularly in preliminary stages before integrating building performance simulations and climate data - it is limited in its capacity for predictive modeling and long-term analysis. Specifically, HDR is not sufficient for assessing daylight variations over extended periods, such as a full month. Therefore, in the main experiment, daylight conditions will be analyzed using 3D modeling in Rhino, with architectural data interpreted through Ladybug Tools and Climate Studio. This climate-based simulation approach enables more comprehensive and dynamic analysis, offering greater accuracy than HDR imagery alone. While HDR remains useful for qualitative assessments - such as generating false-color images to visualize light intensity - climate-based simulations are better suited for in-depth daylighting analysis.

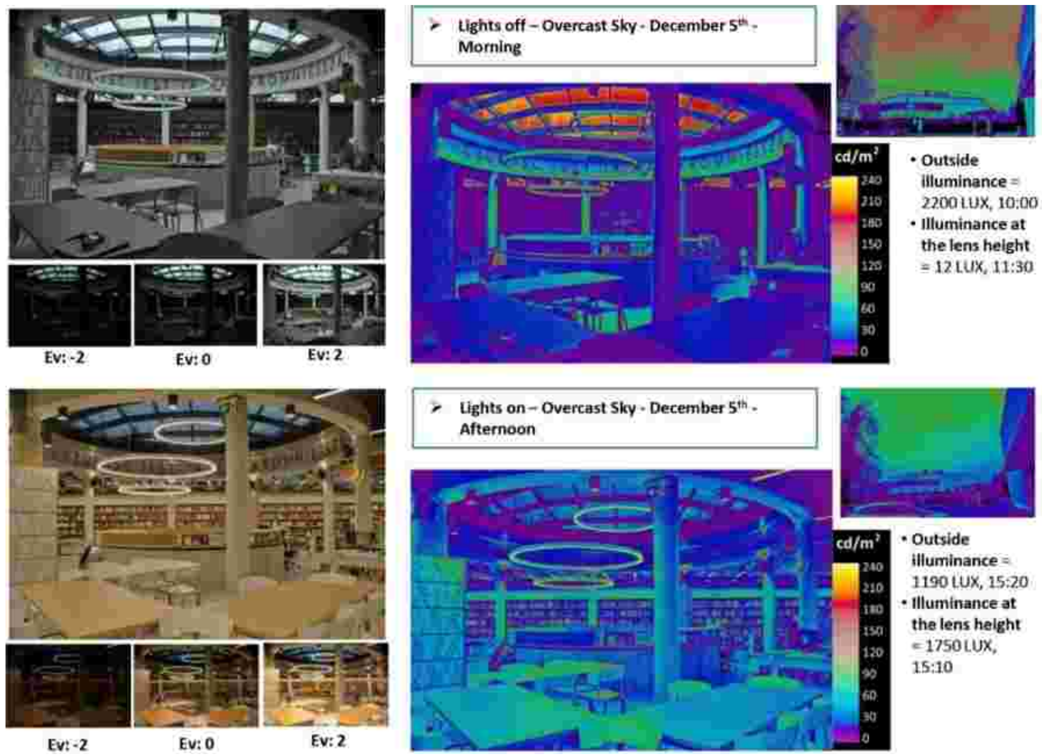


Figure 3.5. False color images showing the luminance difference in the Maly Kack (first floor) (source: author).

3.1.1. Daylight Simulations

One of the most reliable methods for evaluating daylight performance is through computer simulation. Daylight simulation using Radiance-based tools is widely regarded in the scientific community for its accuracy and robustness, supported by numerous validation studies (Reinhart & Walkenhorst, 2001; Mardaljevic, 2000; McNeil & Lee, 2012; Mardaljevic & Prost, 2023). Such simulations provide crucial insights into natural lighting patterns, which contribute to optimizing visual comfort and reducing energy consumption in buildings.

In this research, the software Rhinoceros was selected for conducting the simulations due to its versatility and compatibility with advanced daylighting analysis tools. Specifically, the recently developed plugin AnnuOWL, created by experts and researchers at UCLouvain integrates with the Radiance rendering engine to facilitate detailed annual and periodic daylight simulations (Maskarenj et al., 2022) (Maskarenj et al., 2023).

As outlined in the methodology part of the introduction (refer to Appendix 1), conducting climate-based daylighting analysis requires a well-defined 3D model of the geometry and accurate weather data for the target location (in this case

Oksywie-Gdynia from https://www.ladybug.tools/epwmap/#close) (Ladybug Tools, n.d.). The simulation workflow also supports material definition and importation, allowing for precise replication of interior finishes. For this study, materials closely matching the interior design elements of the libraries were selected to ensure realistic light interaction (see Fig. 3.6).

In addition, AnnuOWL requires the OVNI (Occupant View-based Node Indexing) points to be defined as a separate geometry input. This feature allowed for precise placement of observation points corresponding to the previously identified seating profiles. For the Maly Kack Library, these profiles are illustrated in Fig. 2.22 and Table 2.5; for the Witomino Library, they are shown in Fig. 2.23 and Table 2.6. This functionality in AnnuOWL proved particularly valuable, as it aligned seamlessly with the methodology designed for analyzing user seating positions and correlating them with survey data.

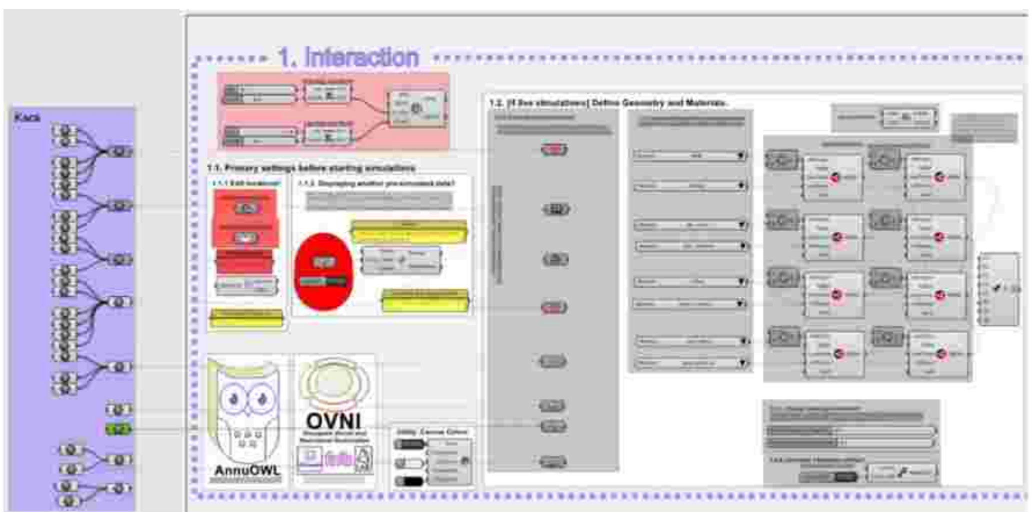


Figure 3.6. The simulation workflow with the internalized geometry in the case of Maly Kack (Source: author).

After finalizing the library geometry and selecting materials that closely represent the actual interior finishes in each library, the simulation process proceeds within the AnnuOWL interface. AnnuOWL offers users flexibility in customizing key simulation parameters, including daylight metrics and their thresholds, all of which are critical for achieving reliable climate-based daylight modeling (CBDM). Therefore, before initiating the simulations, appropriate settings were configured to ensure consistency and accuracy across all simulations. These configurations are essential to reflect the intended performance criteria and to align with the simulation goals outlined in the methodology. The complete simulation setup used throughout this research is illustrated below (Fig. 3.7).

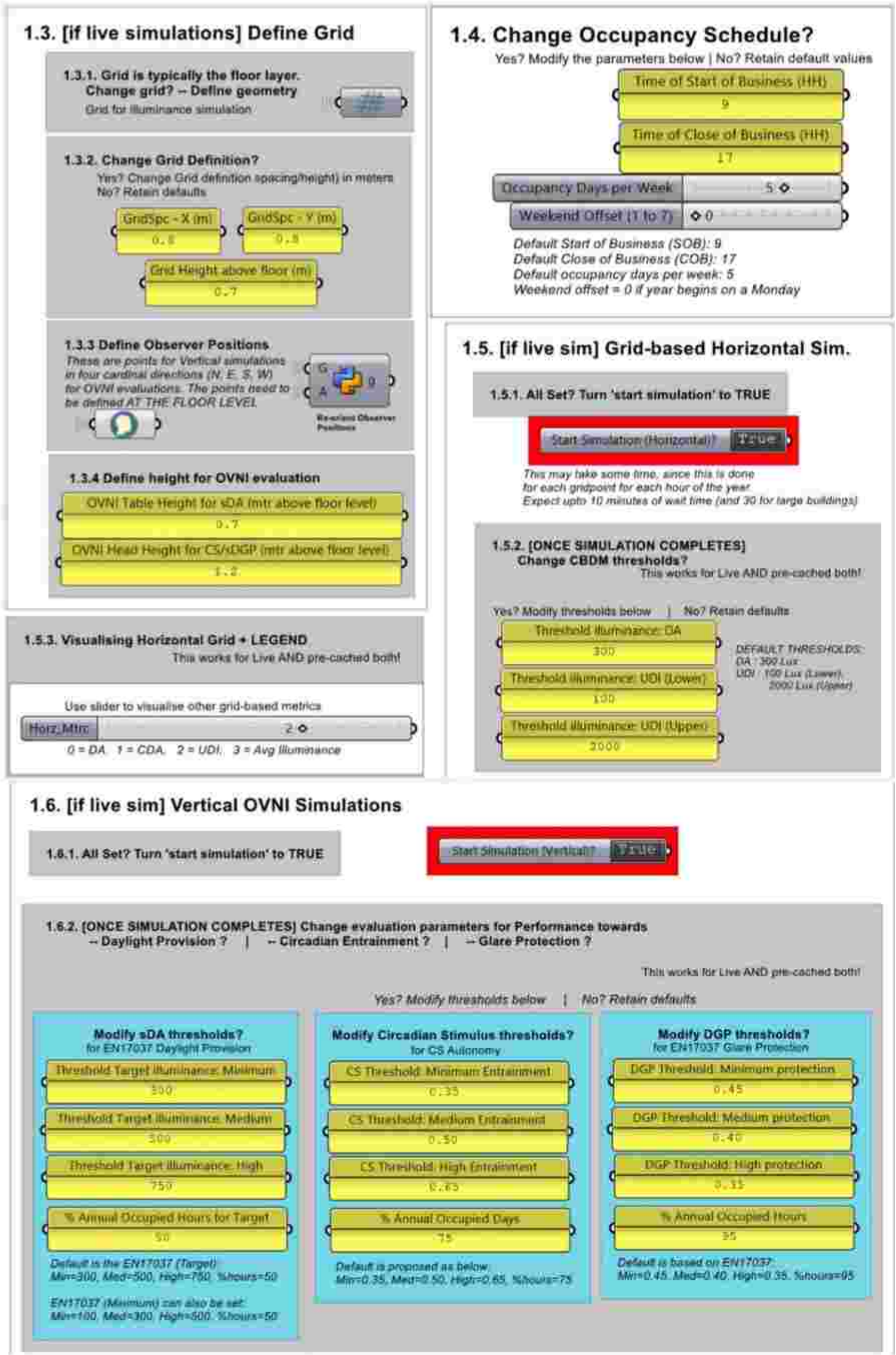


Figure 3.7. Selected setting used for all simulations (Source: author).

The simulation legend is automatically generated by AnnuOWL upon completion of each simulation, and this applies to both the OVNI diagrams and the grid-based daylighting analyses. As explained in methodology part of the introduction (refer to Appendix 1), the simulation mechanism follows a predefined structure based on the EN 17037 standard (European Committee for Standardization, 2019), which governs daylight evaluation in buildings.

Because the legend is standardized and fixed within the AnnuOWL framework - derived directly from the underlying simulation parameters and thresholds - it is consistently applied across all visual outputs. For clarity and ease of interpretation, the legend is presented separately in Figure 3.8 as a point of reference for all subsequent simulation results.

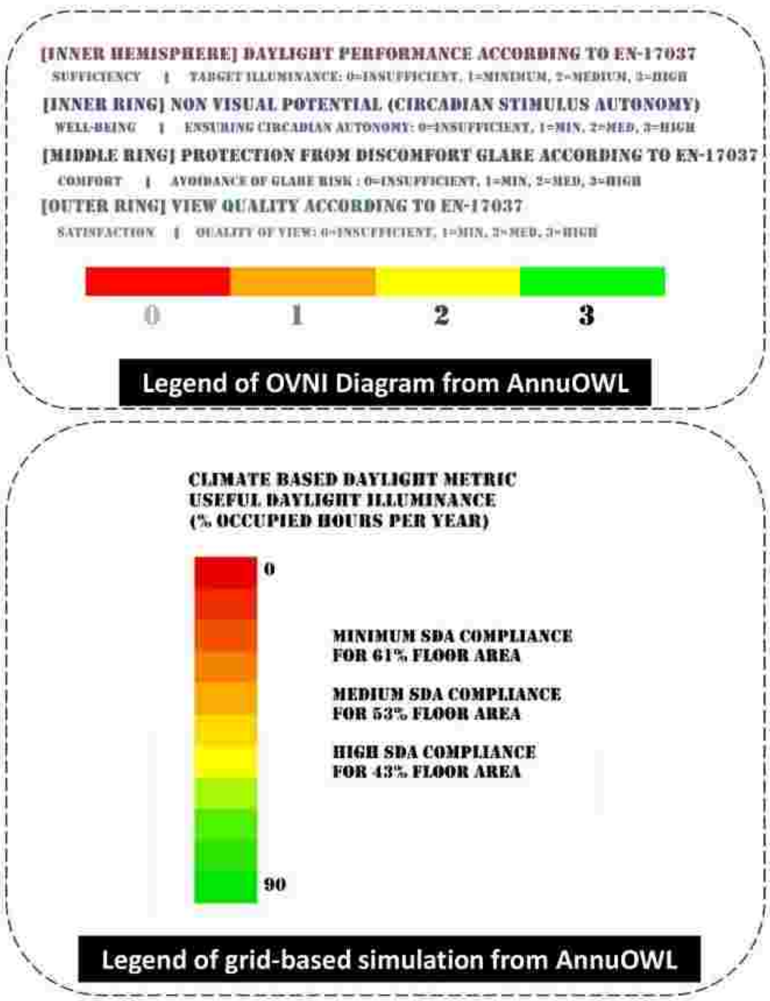


Figure 3.8. Generated legend in AnnuOWL for all simulations (Source: author).

The simulations conducted for this study include annual daylight analyses for both libraries (see Fig. 3.9), as well as targeted periodical simulations. Specifically, the Maly Kack Library was simulated for the months of December, March, and June (Fig. 3.10), and the same monthly simulations were performed for the Witomino Library (Fig. 3.11). These selected time periods correspond to the months during which the user surveys were conducted. The purpose of these simulations is to illustrate seasonal variations in daylight availability and to contextualize user responses based on actual lighting conditions within the spaces.

Figure 3.9. Annual simulations for both libraries (Source: author).

Figure 3.10. Periodical simulations for Maly Kack Library (Source: author).

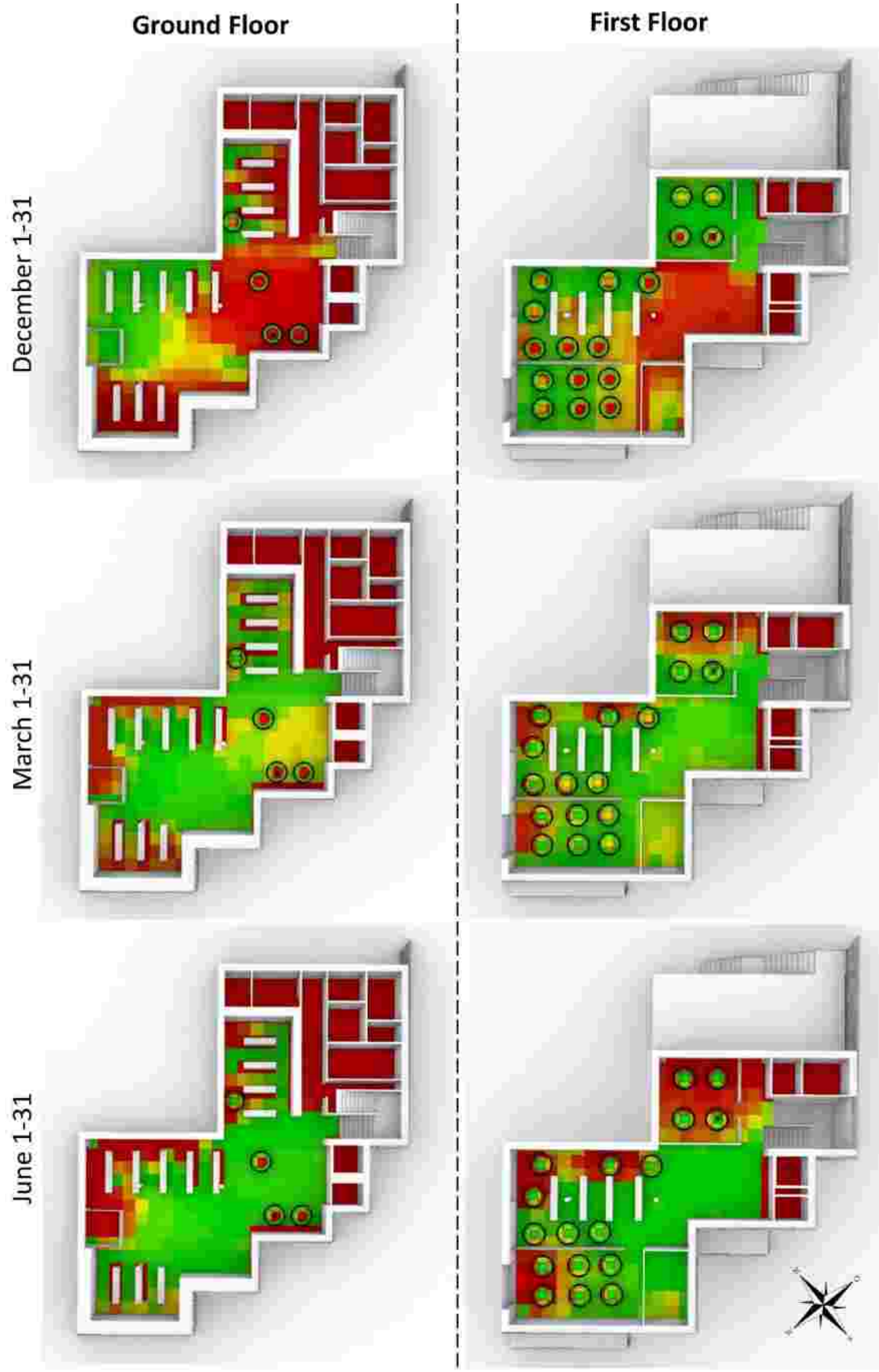


Figure 3.11. Periodical simulations for Witomino Library (Source: author).

3.2. Objective Data Collection and Analysis of Movement Patterns

Space Syntax is used to retrieve objective data on the movement patterns in the case studies. DepthmapX is an open-source spatial analysis software widely used in space syntax research in urban and spatial analysis (Koenig & Varoudis, 2016; Abd El Aziz, 2020, Safizadeh et al., 2023; Yıldırım & Çelik, 2022; Turgut, 2022), architectural studies (Güler & Demirkan, 2024), and one recent publication that touches upon lighting condition as well (Pan et al. 2025). It allows users to perform various types of spatial analyses, including Angular Segment Analysis (ASA) and Visibility Graph Analysis (VGA). These analyses generate a set of spatial metrics such as connectivity, visual integration, mean depth, intelligibility, and entropy, among others. The primary output is a map of angular segment lines or visibility polygons, from which these metrics are calculated and visually represented. In the case of connectivity, for example, each segment is assigned a value based on the number of directly connected segments, helping identify spatial accessibility and potential movement paths.

In addition to visual representations, DepthmapX allows for the export of numerical results in CSV format, enabling further quantitative analysis using tools like Excel, Python, or GIS software. This functionality supports deeper interpretation and comparison across different spatial configurations, such as building layouts or urban environments.

3.2.1. Angular Segment Analysis: Connectivity

After drawing the plans with CAD according to the original plans retrieved from the Gdynia City Hall and the interior plans from Gdynia Library, the following steps were followed to perform space syntax analysis using DepthmapX for the library floor plans, specifically focusing on connectivity analysis:

1. Exporting the floor plan from AutoCAD in simplified single-line format (one-line representation), and saving it as a .dxf file.
2. Importing the .dxf file into DepthmapX as a new map for analysis.
3. Generating the Angular Segment Analysis (ASA) to calculate syntactic values, including connectivity.
4. Simplifying the output by reducing unnecessary or redundant lines using the built-in line-reduction tools in DepthmapX.
5. Exporting the numerical results (e.g., connectivity values) as a .csv file for further processing.

6. **6.** Transforming the segment coordinates into points and lines in Excel, linking them with their respective connectivity values, and visualizing the data in a scatter plot to interpret spatial distribution.

As an example, the process of connectivity data wrangling for the ground floor of the Witomino Library is outlined below (Fig. 3.12). For detailed data processing procedures, please refer to Appendix 4-1 (Maly Kack) and Appendix 4-2 (Witomino).

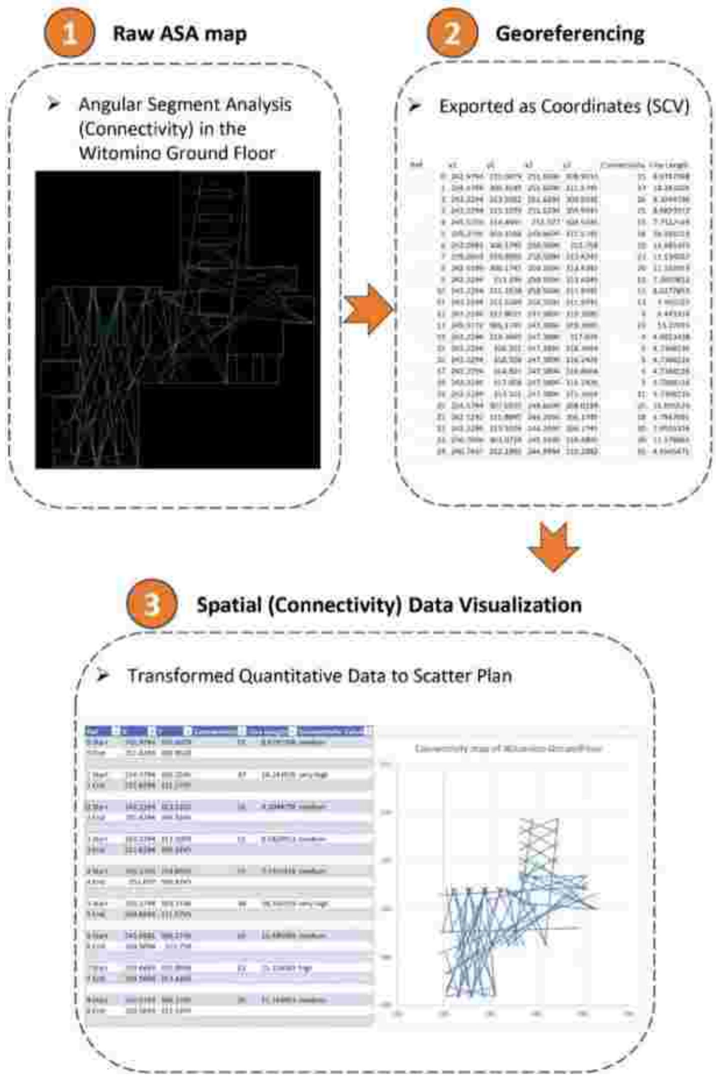


Figure 3.12. The process of data transformation for connectivity values (in case of Witomino Ground floor) (source: author).

This process allowed for filtering the connectivity ranges into four categories of low, medium, high, and very high connectivity for analyzing the seating points after overlaying the connectivity ranges with the seating points. The results of the connectivity analysis for both of the libraries are represented below for Witomino library (Figs. 3.13, and 3.14), and Maly Kack library (Figs. 3.15, and 3.16), respectively.

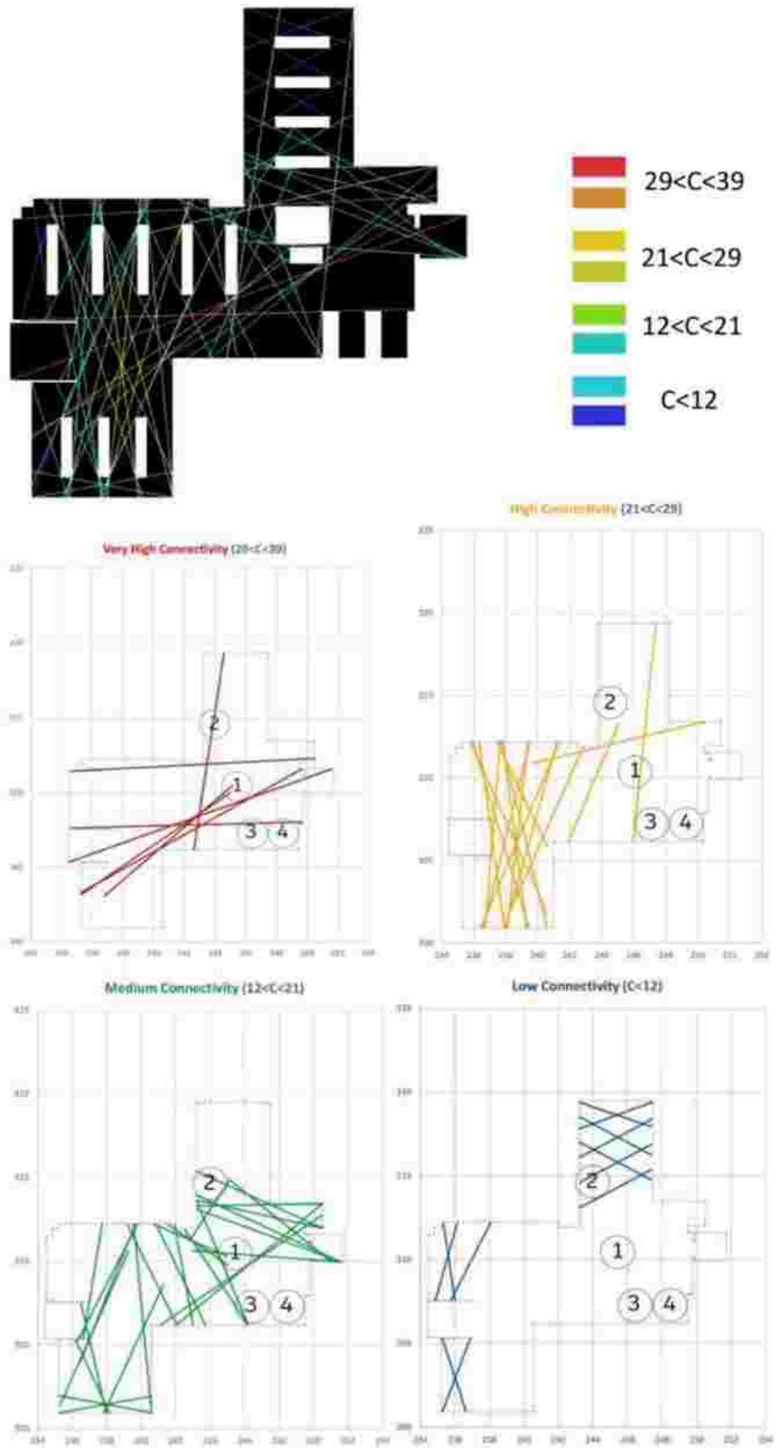


Figure 3.13. Connectivity values and representation for Witomino library (Ground floor) (source: author).

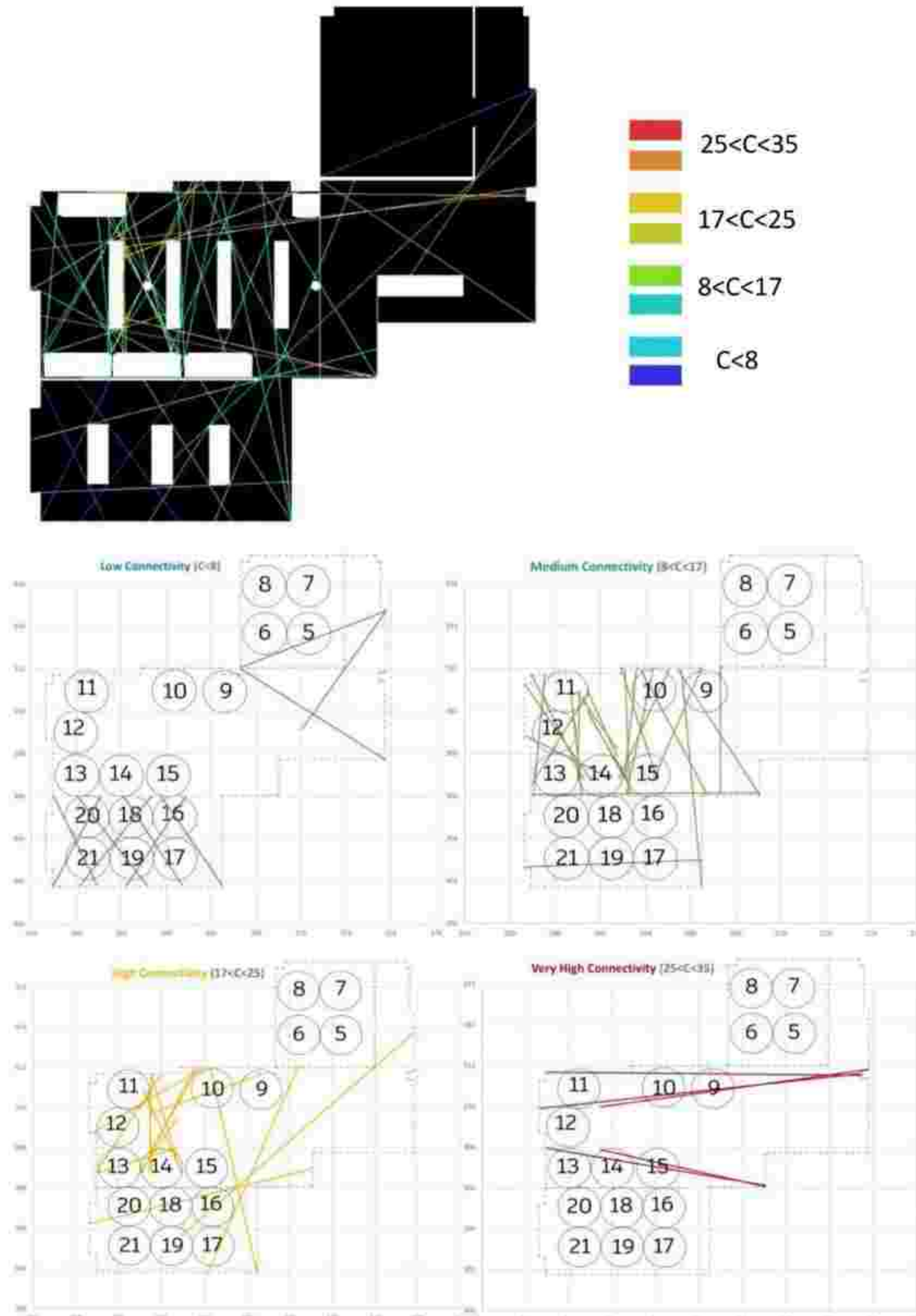


Figure 3.14. Connectivity values and representation for Witomino library (First floor) (source: author).

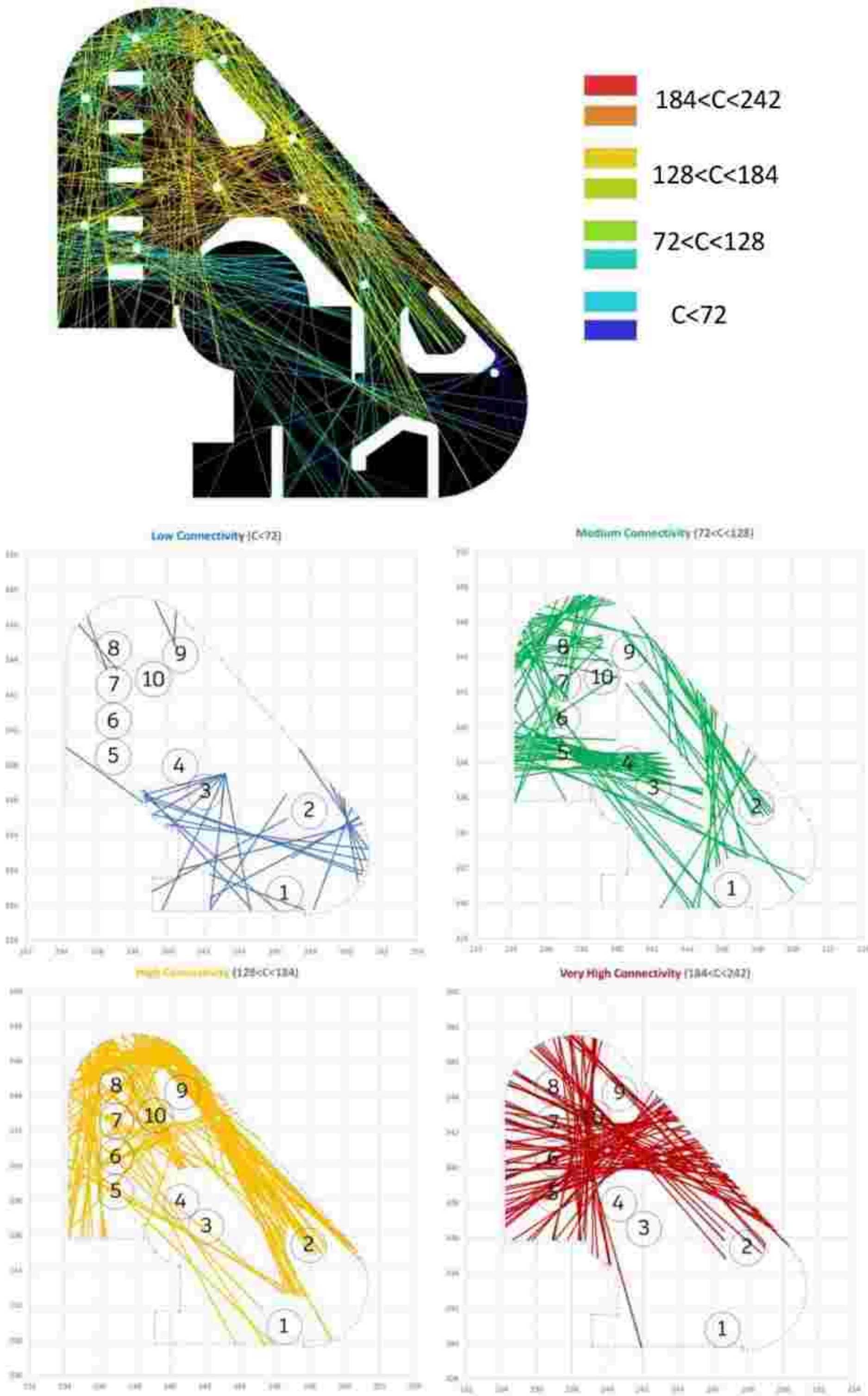


Figure 3.15. Connectivity values and representation for Maly Kack library (Ground floor) (source: author).

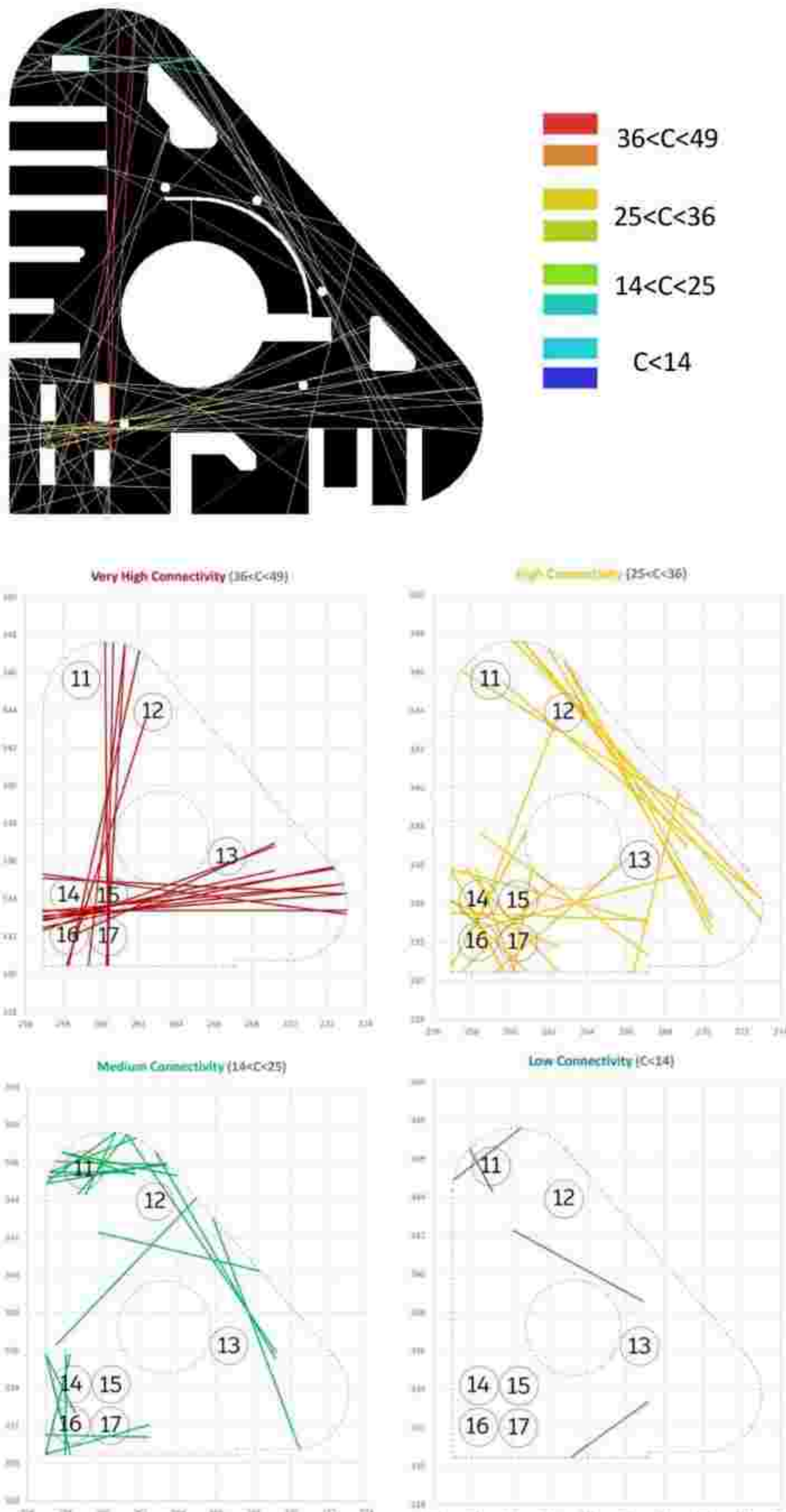


Figure 3.16. Connectivity values and representation for Maly Kack library (First floor) (source: author).

3.2.2. Visibility Graph Analysis (VGA)

The same process with minor changes is repeated for visibility graph analysis:

1. The library floor plan is first exported from AutoCAD in a simplified, single-line format to ensure clarity and compatibility with DepthmapX. The file is saved in the .dxf format.
2. The .dxf file is then imported into DepthmapX as a new map to initiate the visibility graph analysis (VGA).
3. A grid is established across the spatial layout, and the visibility grid is populated using DepthmapX's VGA-specific tools.
4. The Visibility Graph Analysis is run within DepthmapX, generating spatial data based on inter-visibility between points within the grid.
5. The output is then refined by categorizing the visibility values into automatically generated value ranges, each represented by a specific color gradient. To create a clean and focused visual representation, only the relevant color ranges are retained while others are removed manually using Photoshop. These processed visual layers are then overlaid onto the original library floor plans with the defined seating points to communicate the spatial visibility patterns effectively.

It is important to note that the grid in step 3 was generated based on seating and movement dimension requirements for a single person, as defined by Architect's Data (Neufert et al. 2012, Pp. 11-12) (Fig. 3.17).

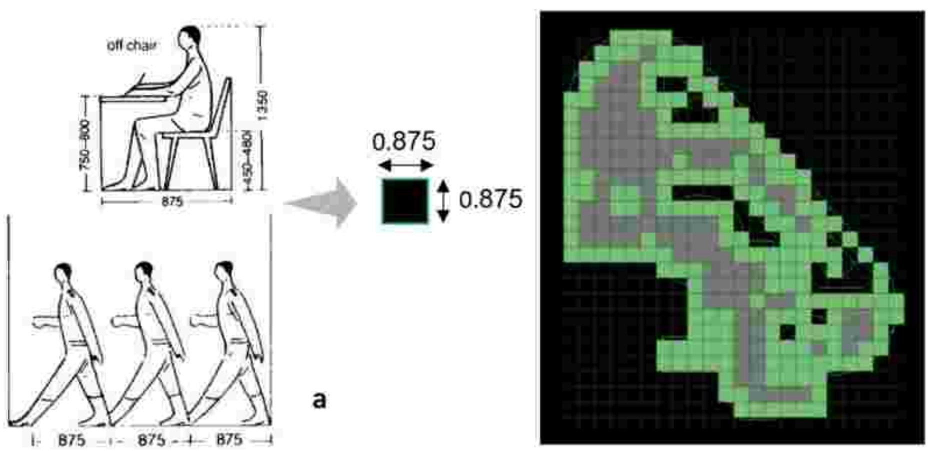


Figure 3.17. Grid generation based on the required spatial dimensions for a person (representation is for the Maly Kack library ground floor) (source a: Neufert et al. 2012, Pp. 11-12) (source: author).

The results of the connectivity analysis for both of the libraries are represented below for Witomino library (Figs. 3.18, and 3.19), and Maly Kack library (Figs. 3.20, and 3.21), respectively.

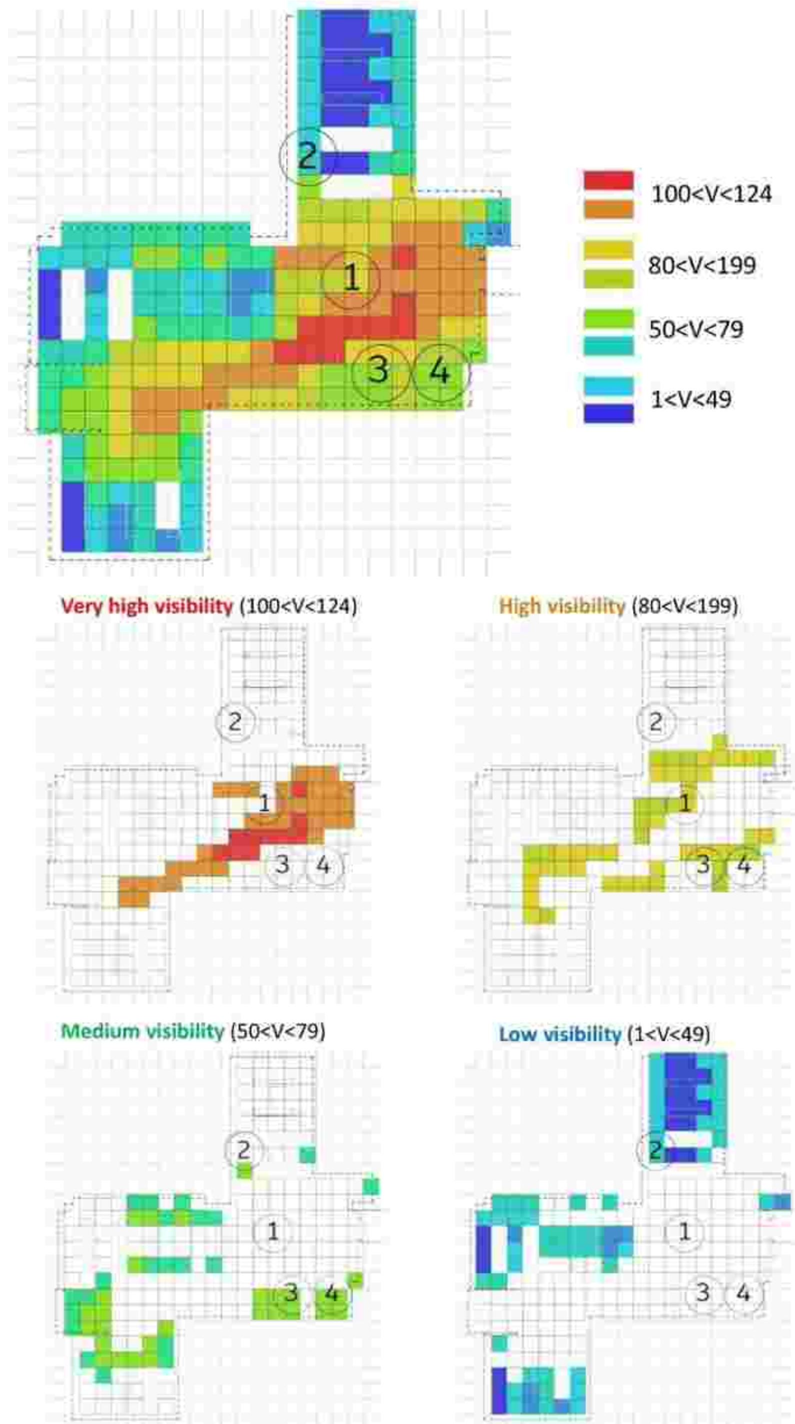


Figure 3.18. VGA analysis for Witomino (ground floor) (source: author).

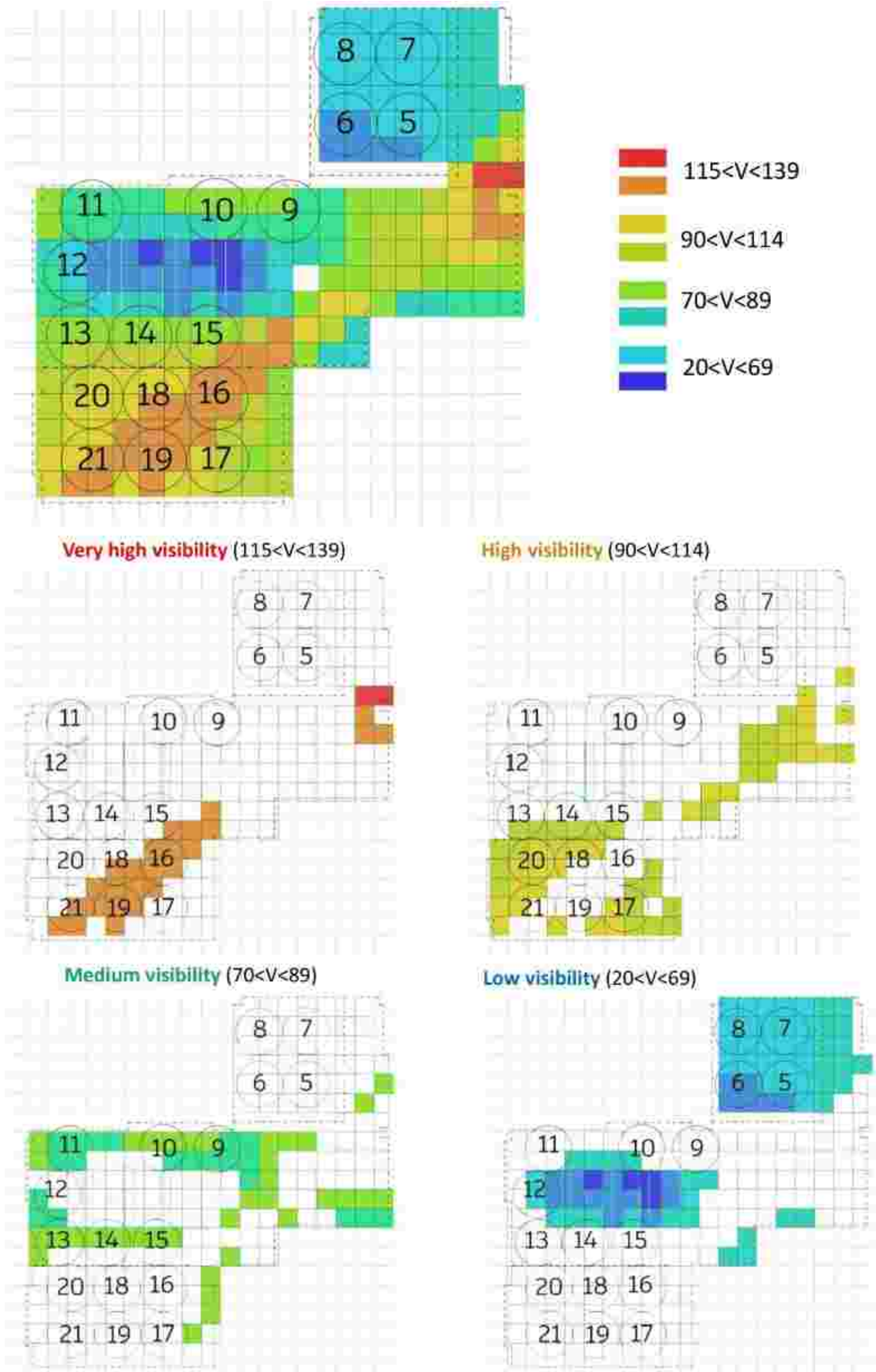


Figure 3.19. VGA analysis for Witomino (first floor) (source: author).

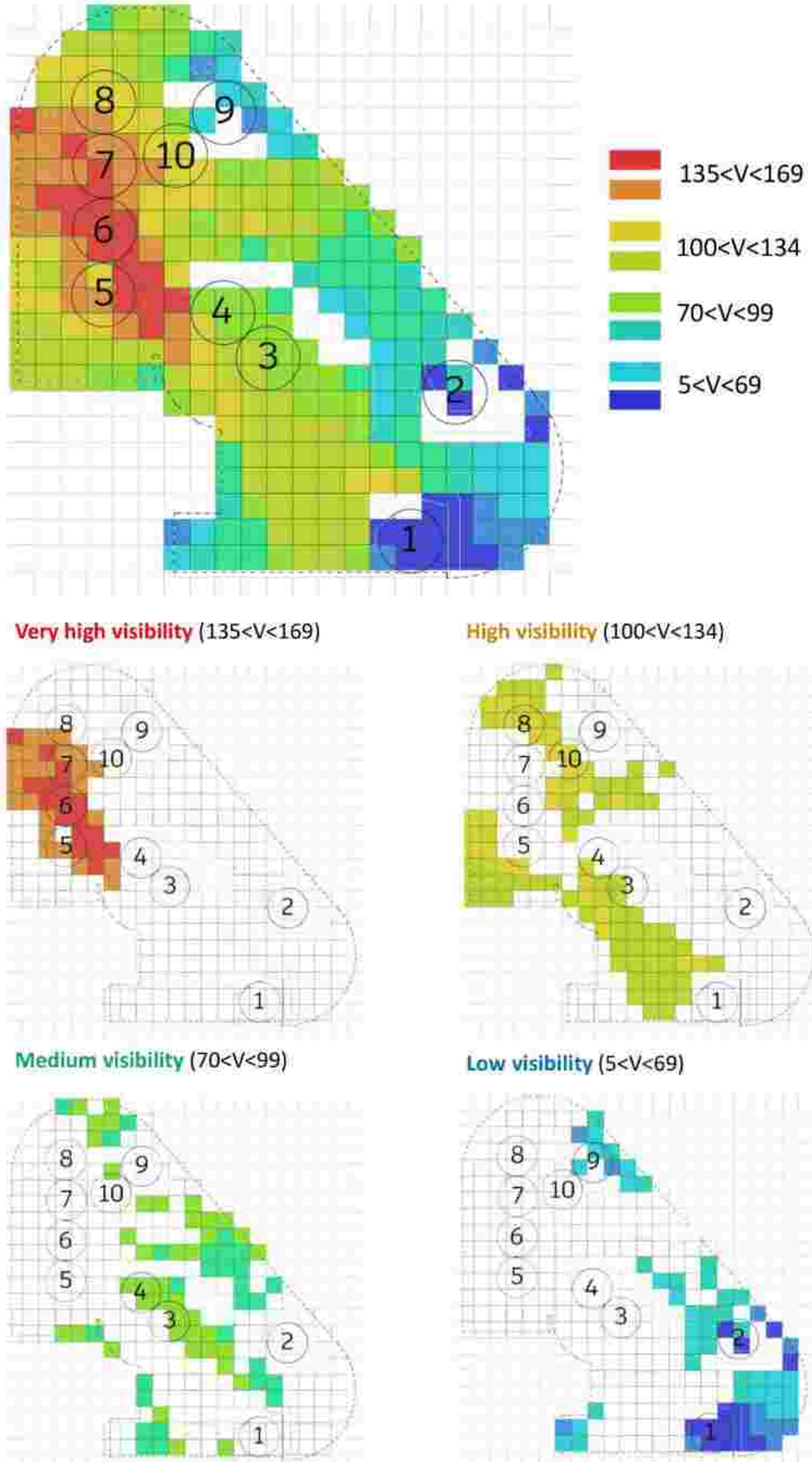


Figure 3.20. VGA analysis for Maly Kack (ground floor) (source: author).

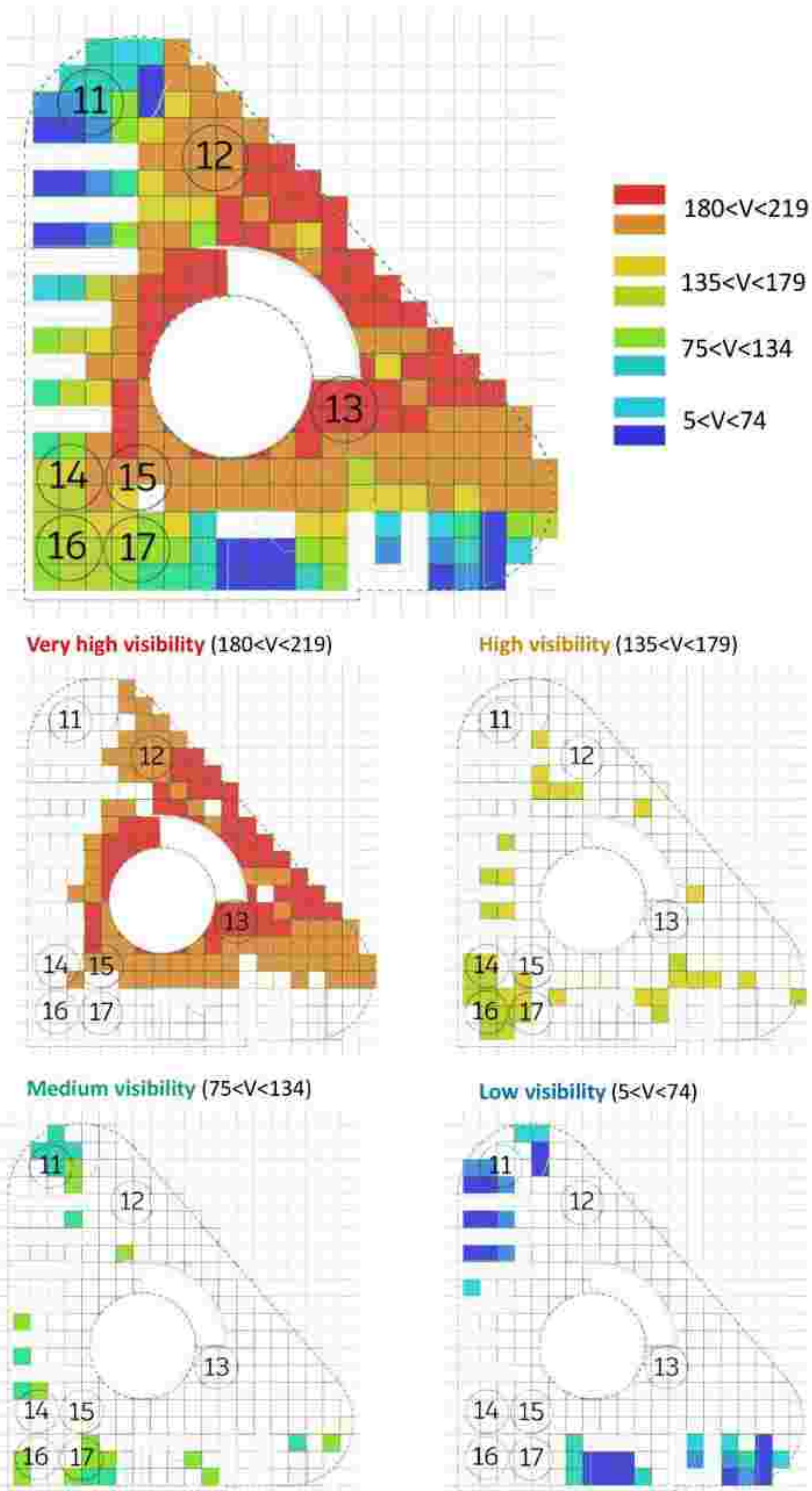


Figure 3.21. VGA analysis for Maly Kack (first floor) (source: author).

Chapter Four

Pattern Recognition and Data Layers Analysis

In the previous chapters, the research design, as well as both subjective and objective data collection methods, along with initial analyses of the raw data, were presented in detail. Subjective data were gathered through questionnaires and systematic observations, while objective data were obtained via daylight and movement simulations using the Grasshopper plug-in AnnuOWL and DepthmapX, respectively. These initial analyses were used to generate visualizations of daylight conditions and to model spatial movement patterns within the study areas.

In this chapter, these outputs - including daylight simulations, movement models, occupancy and behavioral observations, and user perception data - will be further analyzed. Specifically, daylighting conditions will be quantified into scores for each seating point across three defined metrics: UDI (Useful Daylight Illuminance) compliance score, glare compliance score, and daylight sufficiency score. Similarly, movement-related metrics such as visibility and connectivity will be used to generate movement scores for each seating point. Behavioral maps will also be created based on observational data, incorporating spatial efficiency and spatial efficacy scores calculated through methods defined later in this research.

Additionally, data from the user perception questionnaires will be analyzed using Jamovi software to test hypotheses derived from the questionnaire results. Finally, a comprehensive heatmap will be generated to correlate all key variables identified throughout the study, offering an integrated view of spatial, environmental, and behavioral dynamics.

Since the data consists of non-parametric individual measurements, statistical analysis will be carried out using non-parametric statistical methods. These statistical methods are appropriate for this study, as they do not require the assumption of normal data distribution and are well-suited for ordinal or non-normally distributed data:

1. The Mann-Whitney U test will be employed to compare movement behavior between two independent predictor groups, categorized based on either daylighting scores or space syntax metrics.
2. For comparisons involving more than two groups, the Kruskal-Wallis ANOVA will be used to identify statistically significant differences across multiple categories.
3. Additionally, to explore correlations among variables from different datasets, Spearman’s rank-order correlation will be applied. The resulting correlation matrix will be visualized through a heatmap to reveal potential relationships between spatial, environmental, and behavioral variables.

This chapter consists of six main sections, each contributing to a comprehensive spatial analysis framework. The first four sections focus on the detailed visualization and description of datasets collected through four primary methods: daylight simulation, space syntax analysis (computational movement patterns), behavioral observations (including occupancy and movement tracking), and user-perceived data gathered through questionnaires. Each section introduces the methodology used to score the respective datasets, resulting in metrics such as daylighting performance scores, spatial efficacy and movement intensity scores, and observed movement pattern scores.

The fifth section presents a correlation heatmap, synthesizing the collected data to highlight potential relationships between variables across the different data layers. Finally, the sixth section focuses on statistical analysis of the user questionnaires. Here, multiple hypotheses - some derived solely from user perception data and others combining perception with spatial and behavioral metrics - are tested using both pairwise and group comparison methods. This final analysis aims to uncover overarching patterns and draw contextual conclusions from the research (Table 4.1).

Table 4.1. Data visualization and analysis steps.

Step	Data source	Data type/analysis type	Nature of data
Data visualization and description	Questionnaires	Perception-based	Subjective
	Observations	Empirical	Mixed
	Computations	Model-based	Objective
	Simulations	Model-based	Objective
Statistical Analysis	Pairwise and group comparisons	Mann-Whitney U and Kruskal-Wallis tests	Mixed
Data synthesize	All data integrated	Spearman's correlation method	Mixed

4.1. User-Precepted Data Visualization

In total, 89 questionnaires were collected at the Mały Kack branch and 29 at the Witomino branch during three survey periods: December, March, and June (refer to Appendix 3). These figures reflect a realistic outcome based on user availability, engagement levels, and branch-specific attendance patterns.

Justification for the Number of Collected Questionnaires at Mały Kack and Witomino Libraries:

- According to the official 2023 report (Czytelnicy - 2023 r.) (Wojewódzka i Miejska Biblioteka Publiczna w Gdańsku, 2024), the Miejska Biblioteka

Publiczna w Gdyni recorded 497,697 visits across 20 branches (Biblioteka Gdynia, n.d.). This translates to a rough average of 2,073 visits per branch per month. However, attendance is not evenly distributed. Branches such as Mały Kack and Witomino, located in residential districts, are characterized by lower-than-average visitor numbers.

- The survey targeted only those users who remained in the library to read or work, excluding individuals who briefly visited to borrow or return items. This significantly narrowed the pool of potential respondents and ensured that data collected pertained to users actively engaging with the space.
- The expected response numbers were further informed by librarian insights at both branches. Staff at Witomino advised that around 8-15 responses per month would be realistic, which aligns closely with the 29 responses gathered. At Mały Kack, the environment allowed for a higher response rate than initially anticipated, resulting in 89 completed questionnaires.
- Additional factors influencing response volume included users' willingness to participate, availability of time, and respect for privacy. Survey participation was strictly voluntary and conducted ethically, which may have limited but strengthened the quality of the data.

In the chapter 2, the initial reference to the questionnaire results was made to develop seating profiles based on three specifically designed questions. In this section, however, a more comprehensive approach is taken - both holistic and detailed - where the results from all questionnaire items are presented through graphs and accompanied by descriptive analysis and statistical analysis of the user questionnaires to uncover underlying trends and patterns.

Question 13 of the questionnaire stands out as a key item that can be analyzed independently. It asks users to express their level of agreement with four interrelated statements designed to assess the influence of daylighting on seat selection. The statements address factors such as view-out, visual appeal, potential distraction, and ability to focus. These four factors are critical to be studied for their importance in the study of learning environments and daylighting conditions. For example, research in learning and library environments confirms that daylight availability has a significant impact on seat preference and is frequently cited as a primary reason users select or avoid certain seating (İzmir Tunahan, 2021). Studies also indicate that access to outdoor views - particularly natural elements - can enhance psychological well-being, reduce stress, and improve concentration, which supports the inclusion of the "view-out" parameter (Gou et al., 2018). Finally, findings from environmental psychology link daylight exposure to enhanced cognitive performance, including improved focus, alertness, and memory, validating its assessment within user studies of library seating behavior (Siraji et al., 2022).

Figures below represent the daylight impact on the seating choice in Maly Kack library (an open-plan library with skylight) (Fig. 4.1) and Witomino library (a segmented plan library with defined zones) (Fig. 4.2).

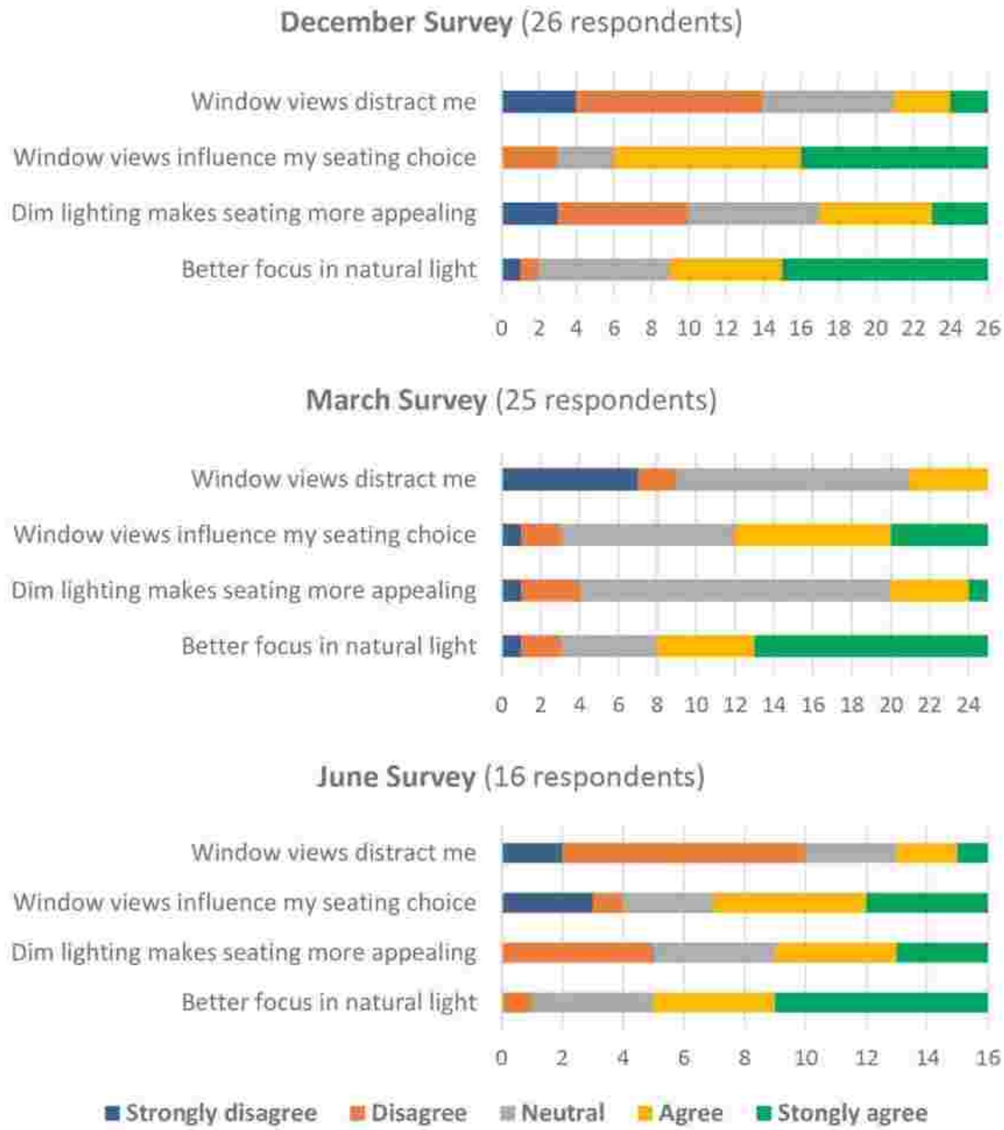


Figure 4.1. Daylight Impact on Seating: Survey in Maly Kack library.

According to the stacked bar chart (Fig. 4.1), the perception of better focus in natural light within the open-plan library remained consistent across the three survey months, indicating that the amount of daylight entering the space did not significantly affect users' reported ability to focus. Overall, the level of agreement with the statement regarding better focus in natural light was relatively high.

Regarding the influence of window views on seating choice, users showed stronger agreement in December, but this agreement gradually decreased from March to June, with more users disagreeing over time. While the reported distraction from window views remained nearly constant, most users tended to disagree or strongly disagree that window views were distracting, suggesting that distraction may not be an issue affecting the influence of window views on seating choice.

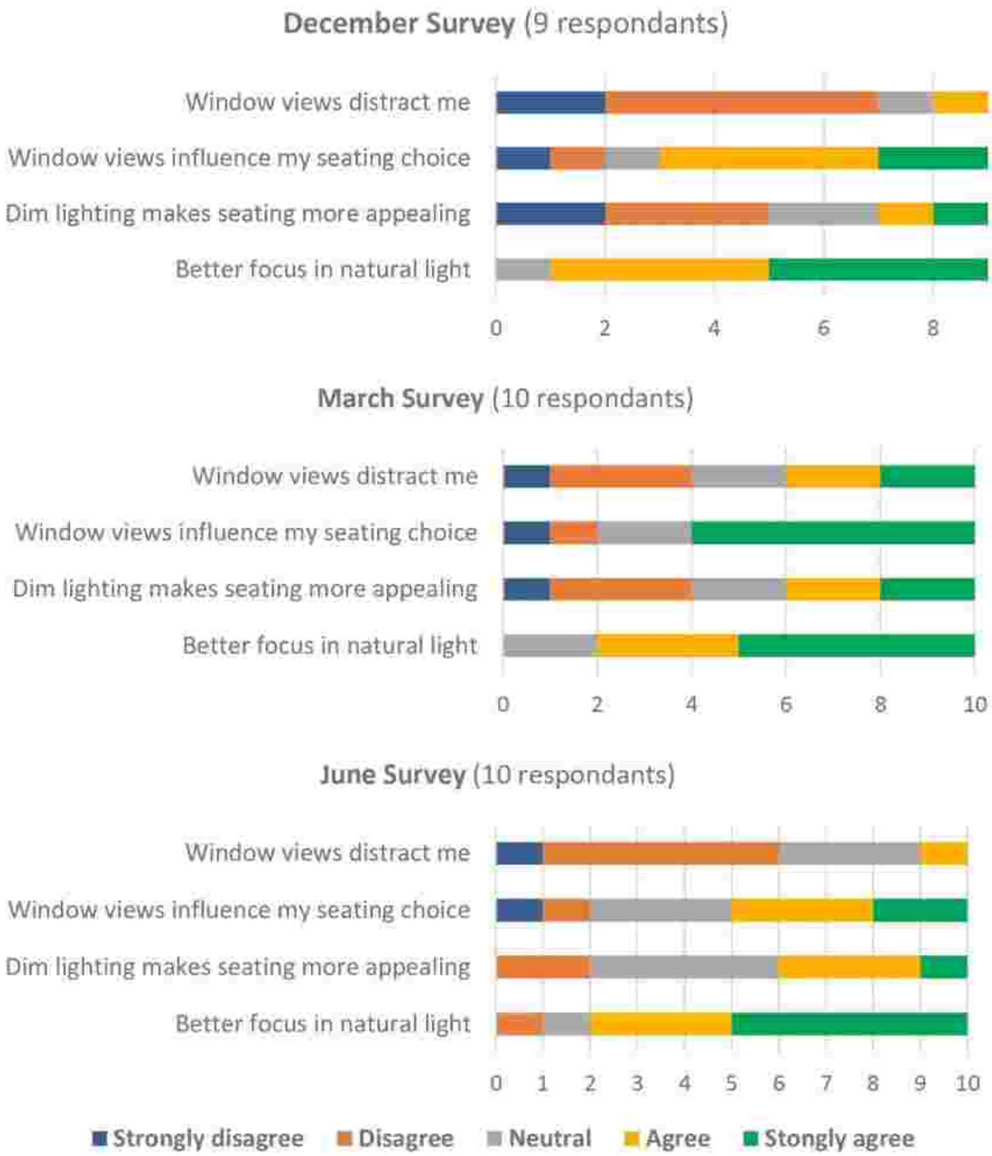


Figure 4.2. Daylight Impact on Seating: Survey in Witomino library.

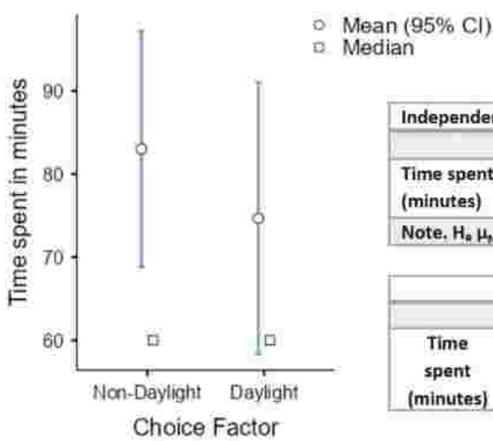
On the other hand, in the library with enclosed spaces and segmented zones (Fig. 4.2), although the change is not highly significant, there is a noticeable decrease in the number of users who disagree with the statement that dim lighting makes seating more appealing. This suggests that from winter to summer, daylight becomes increasingly preferred in the enclosed library setting.

4.1.1. Statistical Analysis of User-Questionnaire Data

Based on the structure of the questionnaire and the interrelations among its data points and questions, several analytical comparisons can be formulated that stem directly from its design. In this section, the most relevant relationships to the research topic are presented and analyzed. Given the non-parametric nature of the data, either pairwise Mann–Whitney U tests or Kruskal–Wallis ANOVA tests are employed for the statistical analysis. These statistical analysis are conducted with Jamovi software.

A) Preference for daylighting in seat selection influences time spent in that location.

- **Predictor Groups (from the question 2 in the questionnaire):**
  Selected the location due to better daylighting
  Selected the location for other reasons
- **Outcome value (from the question 9 in the questionnaire):**
  Measured time spent



Independent Samples T-Test			
		Statistic	p
Time spent (minutes)	Mann-Whitney U	1623	0.452
Note. H_a $\mu_{Non\text{-}Daylight} > \mu_{Daylight}$			

Group Descriptives						
	Group	N	Mean	Median	SD	SE
Time spent (minutes)	Non-Daylight	73	83.0	60.0	62.0	7.25
	Daylight	45	74.7	60.0	56.0	8.35

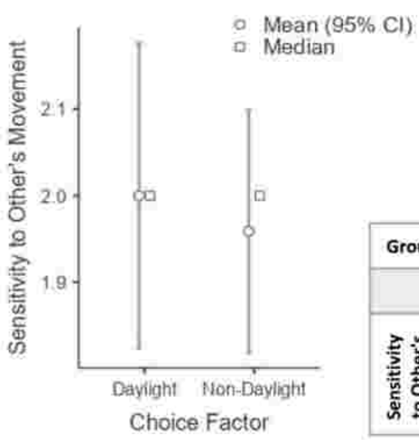
Figure 4.3. U-test descriptive plot and tables for the Test A.

According to the U-test analysis for Test 1 (Fig. 4.3), although the Non-Daylight group in both libraries (those who selected seating based on factors other than daylight) tended to spend slightly more time - with a mean of approximately 85 minutes - compared to the Daylight group (those who chose their seating due to daylight), who had a mean of approximately 75 minutes, the p-value indicates that no statistically significant difference was observed. This suggests that the difference is not statistically significant. Therefore, additional data would be needed to support the analysis.

Although the current analysis did not find a statistically significant difference, the observed trend - where users who prioritize factors other than daylight tend to spend more time in the library - suggests potential design implications. Provided that future research with larger samples confirms this relationship, architects and planners might consider emphasizing factors beyond daylighting when designing spaces intended for prolonged use. This could include prioritizing comfort, privacy, acoustics, and other environmental qualities that encourage longer stays. Nonetheless, daylight remains an important element for overall user well-being and should be integrated thoughtfully to balance diverse user needs.

B) Preference for daylighting in seat selection influences the preference for observing other users' movement in the library.

- **Predictor Groups (from the question 2 in the questionnaire):**
  Selected the location due to better daylighting
  Selected the location for other reasons
- **Outcome value (from the question 19 in the questionnaire):**
  The importance of noticing other's movement in the library
  Less likely to stay Score = 1
  No effect Score = 2
  More likely to stay Score = 3



Independent Samples T-Test			
		Statistic	p
Sensitivity to Other's Movement	Mann-Whitney U	1587	0.722
Note. H_a $\mu_{Daylight} \neq \mu_{Non-Daylight}$			

Group Descriptives						
	Group	N	Mean	Median	SD	SE
Sensitivity to Other's Movement	Daylight	45	2.00	2.00	0.603	0.0899
	Non-Daylight	73	1.96	2.00	0.611	0.0715

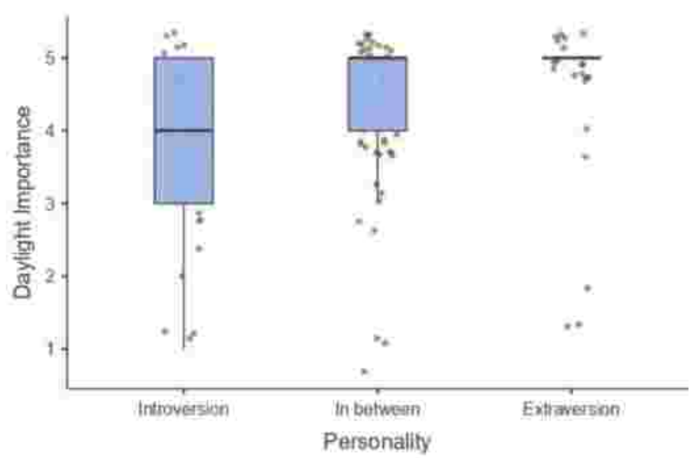
Figure 4.4. U-test descriptive plot and tables for the Test B.

According to the U-test analysis for the Test B (Fig. 4.4), although the Non-Daylight group in both libraries (those who selected seating based on factors other than daylight) tended to be slightly lesser sensitive to the movement of other users compared to the Daylight group (those who chose their seating due to daylight), the p-value indicates that no statistically significant difference was observed. This suggests that the difference is not statistically significant. Therefore, additional data would be needed to support the analysis.

This suggests that additional data collection is needed to better understand the potential relationship between sensitivity to others' movement and the prioritization of daylight when selecting seating. Gaining clearer insights into this relationship could inform architectural decisions regarding the design of transparency and open spaces in libraries, ultimately enhancing user comfort and satisfaction.

C) Personality type influences the preference for daylight in the library.

- **Predictor Groups (from the question 16 in the questionnaire):**
  Introvert Individuals
  Extrovert Individuals
  Individuals In-between
- **Outcome value (from the question 12 in the questionnaire):**
  The importance of daylight to the user in Likert scale (from Irrelevant to Highly Important).



One-Way ANOVA, Kruskal-Wallis				
	χ^2	df	p	ε^2
Daylight Importance	8.17	2	0.017	0.0716

DSCF Pairwise comparisons - Daylight Importance			
		W	p
Introversion	In between	2.83	0.112
Introversion	Extraversion	3.56	0.032
In between	Extraversion	2.14	0.286

Figure 4.5. ANOVA-test descriptive plot and tables for the Test 3.

According to the ANOVA-test analysis for the Test 3 (Fig. 4.5), the result is statistically significant and there is a significant difference in perceptions of daylight importance among the groups. However, only Introverts and Extraverts differ significantly in their perceived importance of daylight ($p = 0.032$). The other pairs (Introvert vs In-between and In-between vs Extravert) do not show significant differences. Pairwise comparisons using the DSCF test revealed a significant difference between introverts and extraverts in perceived daylight importance ($W = 3.56$, $p = 0.032$), with extraverts placing greater importance on daylight in the library setting.

While it's not practical to identify each user's personality type, knowing how personality correlates with daylight preferences guides architects to design inclusive, flexible, and varied environments that accommodate different user needs and behaviors. Libraries and public spaces can be zoned or programmed to provide options that implicitly meet these needs:

I. Bright, daylight-rich spaces for those who seek stimulation (likely extraverts).
II. More enclosed, lower-light spaces for those who prefer calm and privacy (likely introverts).

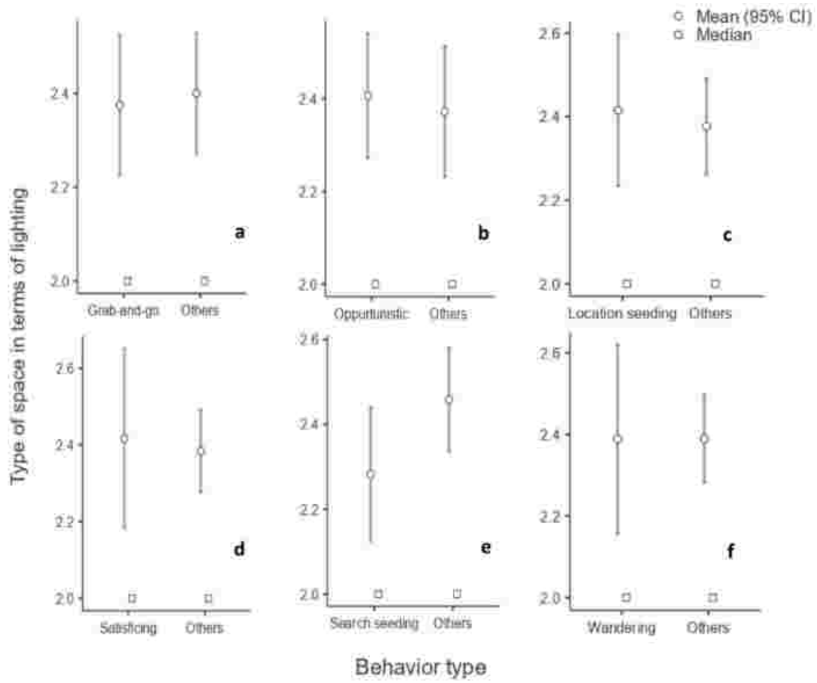
D) Library user behavior type {} tend to prefer spaces with Naturally lit space.

- **Predictor Groups (from the question 18 in the questionnaire):**
  A certain type of behavior
  Other behavior types combined
  Behavior types: Grab-and-go, Satisficing, Opportunism, Seeding by search, Seeded by location, Wandering
- **Outcome value (from the question 17 in the questionnaire):**
  Naturally lit space with direct sunlight score = 3
  Daylit space with artificial lighting score = 2
  Artificially lit space without sunlight score = 1

The Mann-Whitney U test for Test D (Fig. 4.6) revealed that only the 'Seeding by search' behavior type showed a statistically significant difference in lighting preference. Specifically, individuals engaging in this behavior are less likely to prefer naturally lit spaces with direct sunlight compared to other user types.

From an architectural and spatial design standpoint, this result offers valuable insight into how lighting conditions intersect with user behavior in browsing sections. Task-driven focus over atmosphere created by sunlight, and preference for diffused lighting implies that this group likely favors daylit spaces with artificial lighting or fully artificial lighting, which offer uniform, stable illumination and allow them to scan large volumes of material without distraction or discomfort.

To support search-seeding behavior in libraries, high-glare, naturally lit zones should be avoided near dense shelving areas; instead, stack zones should be designed with indirect daylighting, solar control, or diffused artificial lighting to create visually quiet, low-contrast environments conducive to focused browsing, comparison, and triage, while reading lounges may benefit from warmer, naturally lit atmospheres suited to more contemplative use.



		Independent Samples T-Test (a)		Independent Samples T-Test (b)		Independent Samples T-Test (c)	
		Stats	p	Stats	p	Stats	p
Type of space in terms of lighting	Mann-Whitney U	1634	0.774	1695	0.389	1498	0.301
Note. H_a $\mu_{Opportunistic} > \mu_{Others}$							

		Independent Samples T-Test (d)		Independent Samples T-Test (e)		Independent Samples T-Test (f)	
		Stats	p	Stats	p	Stats	p
Type of space in terms of lighting	Mann-Whitney U	1082	0.363	1392	**0.047**	889	0.541
Note. H_a $\mu_{Opportunistic} > \mu_{Others}$							

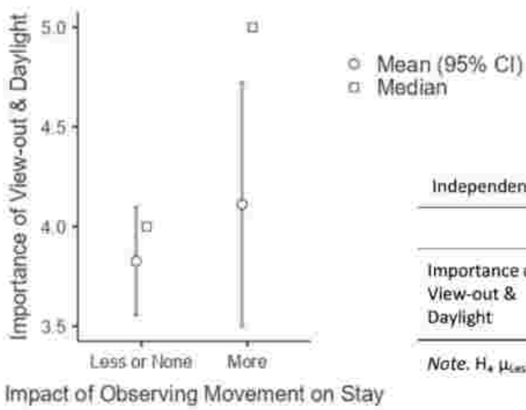
Group Descriptives (e)

	Group	N	Mean	Median	SD	SE
Space Type in Terms of Lighting	Search seeding	46	2.28	2.00	0.544	0.0802
	Others	72	2.46	2.00	0.529	0.0624

Figure 4.6. U-test descriptive plot and tables for the Test D.

E) Users who are more likely to stay in the library when observing other people's movement tend to rate daylight and view out as more important compared to users who are less likely to stay or not affected.

- **Predictor Groups (from the question 19 in the questionnaire):**
  Less likely and No Impact - observing others makes them less likely to stay or does not have any impact
  More likely - observing others makes them more likely to stay
- **Outcome value (from the question 12 in the questionnaire):**
  Importance of view out and daylight (measured on a Likert scale



Independent Samples T-Test

		Statistic	p
Importance of View-out & Daylight	Mann-Whitney U	758	**0.158**

Note. H_+ $\mu_{Less\ or\ None} < \mu_{More}$

Group Descriptives

	Group	N	Mean	Median	SD	SE
Importance of View-out & Daylight	Less or None	98	3.83	4.00	1.36	0.138
	More	18	4.11	5.00	1.32	0.312

Figure 4.7. U-test descriptive plot and tables for the Test E.

According to the Mann-Whitney test analysis for Test E (Fig. 4.7), no statistically significant difference was found in the perceived importance of daylight and daylight/view-out among the three groups defined by how observing other users' movement affects their willingness to stay ($H = 2.97$, $p = 0.158$).

Despite the lack of statistical significance, the descriptive data point to a possible link between users' preference for daylight/view out and their attentiveness to social dynamics in the space, such as movement of others. This may reflect an underlying tendency toward environmental and social sensitivity in spatial preferences.

4.2. Behavioral Mapping and Analysis

Chapter 2 presented the observation sheets used by both the librarians and the researcher. The strategy for recording behavioral data - such as user movement, occupancy counts, duration of stay, and relocation between seating points - was carefully designed to minimize observer bias and enhance the quality of observations. This was achieved by involving both trained librarians (who were instructed on how to complete the observation sheets) and the researcher in the data collection process. Next, observations were conducted over ten days each month for every library: five days by the researcher and five by the librarians. These observations were then combined to construct a representative week of user activity per month. Specifically, four days of data from the researcher and three days from the librarians were selected to create a composite observation week for December, March, and June. However, an exception occurred in December for the Witomino library. Due to the observation period starting in the second week of the month and a notable decline in user attendance in the later days - largely due to the Christmas holiday - only five days of observation were conducted. The remaining two days were not recorded, as the library was mainly visited for brief browsing or book rentals, with no users occupying the seating areas during those times.

The detailed results of these observations are presented in the accompanying spreadsheets for each library: Maly Kack (see Appendix 5-1) and Witomino Library (see Appendix 5-2). The process of recording observational data in the spreadsheets involved two main tables. The first table documented the number of users occupying each seat, while the second recorded the duration of their stay. The rows in the second table were determined based on the highest number of users observed at any seating point during that particular week of observation. To assess the efficacy of each seating point, the data from these two tables were multiplied - user count by duration of stay - for each point in each observation period. This approach provided a relatively balanced measure of seating efficacy for each week and each library.

The formulas used to calculate this relative balanced efficacy are presented below (see Formulas 1 and 2). A log transformation was applied to reduce the impact of outliers and normalize the data by compressing large values. This helped in making the distribution more symmetrical and suitable for analysis.

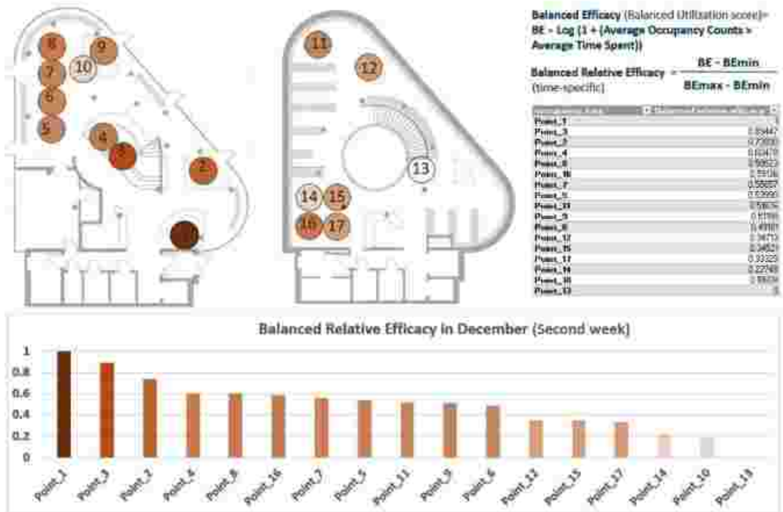
$$Balanced\ Efficacy = BE = Log\big(1 + (Average\ Occupancy\ Counts \times Average\ Time\ Spent)\big) \quad (1)$$

$$Balanced\ Relative\ Efficacy = \frac{BE - BEmin}{BEmax - BEmin} \quad (2)$$

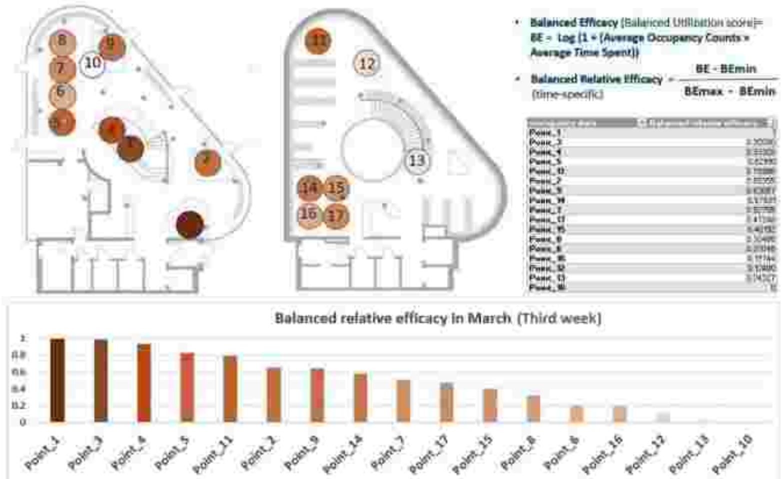
Based on the observations, then, the spatial efficacy maps of the Maly Kack library (Fig. 4.8) and Witomino library (Fig. 4.9) are presented below. In addition, to analyze user movement patterns during the observation periods, an origin-destination matrix was developed to map the connections between seating points (refer to the Appendix 5-1, and 5-2). For each observation day and time period, arrows indicating user relocation from one point to another were recorded and counted. These relocation counts were then used to populate the matrix.

Based on this matrix, a graph was generated to visualize the popularity of each seating point, as measured by the number of relocations to that point. This graph reflects the movement intensity and helps illustrate user flow dynamics within the space during each observation period. The graphs depicting the movement intensity of each period of observation for Maly Kack library (Fig. 4.10) and Witomino library (Fig. 4.11) are presented in the next pages.

❑ **December** (2nd week) (Total recorded seat usage: 256)



❑ **March** (3rd week) (Total recorded seat usage: 286)



❑ **June** (3rd week) (Total recorded seat usage: 247)

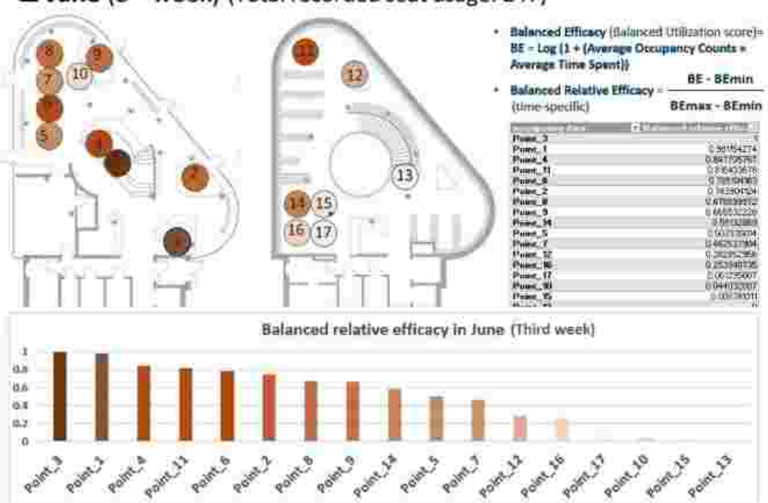
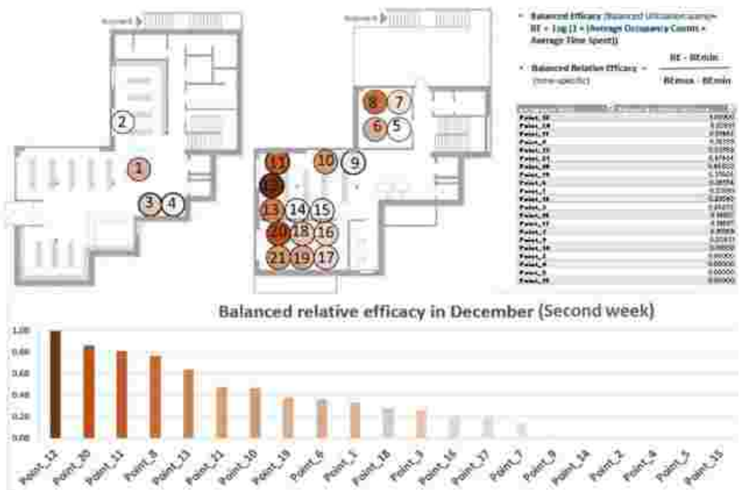
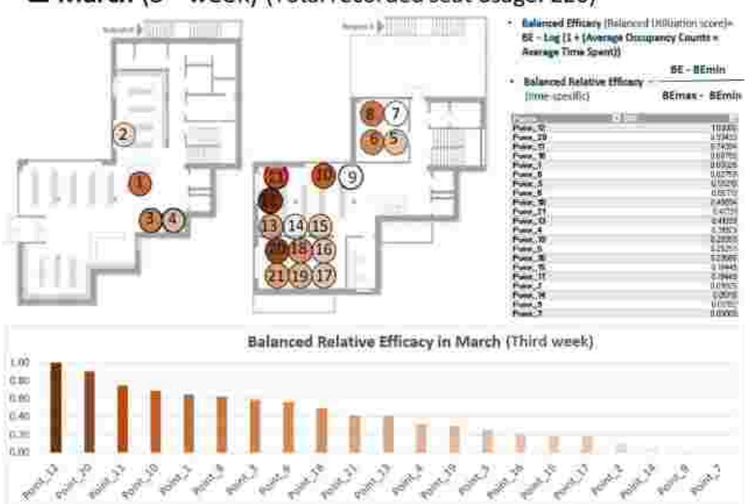


Figure 4.8. Spatial efficacy in the Maly Kack library.

❑ **December** (2nd week) (Total recorded seat usage: 137)



❑ **March** (3rd week) (Total recorded seat usage: 220)



❑ **June** (3rd week) (Total recorded seat usage: 212)

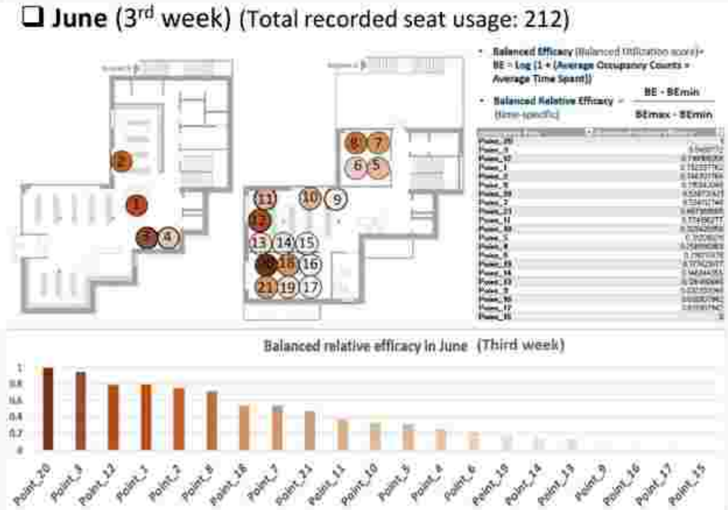


Figure 4.9. Spatial efficacy in the Witomino library.

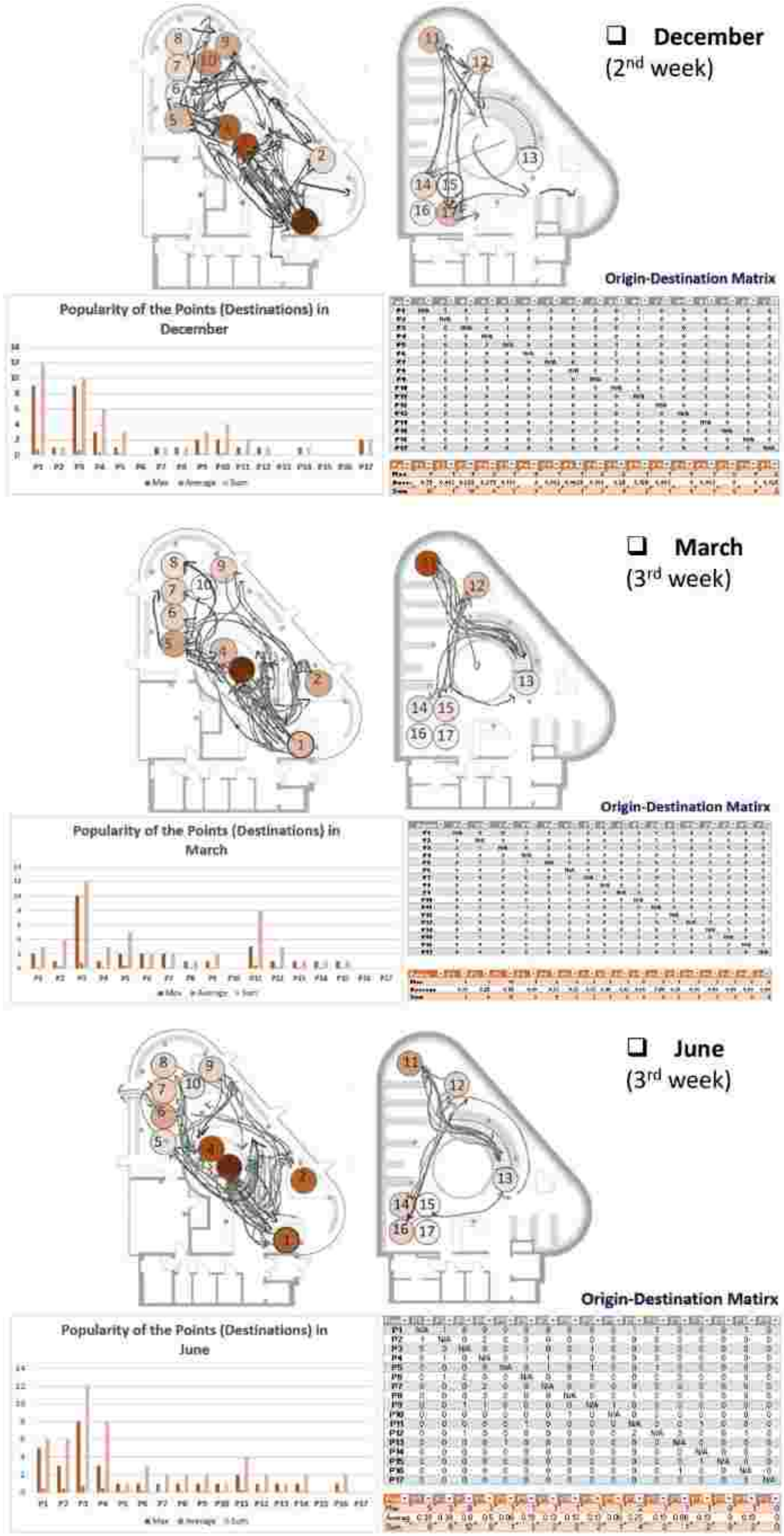


Figure 4.10. Movement Intensity in the Maly Kack library.

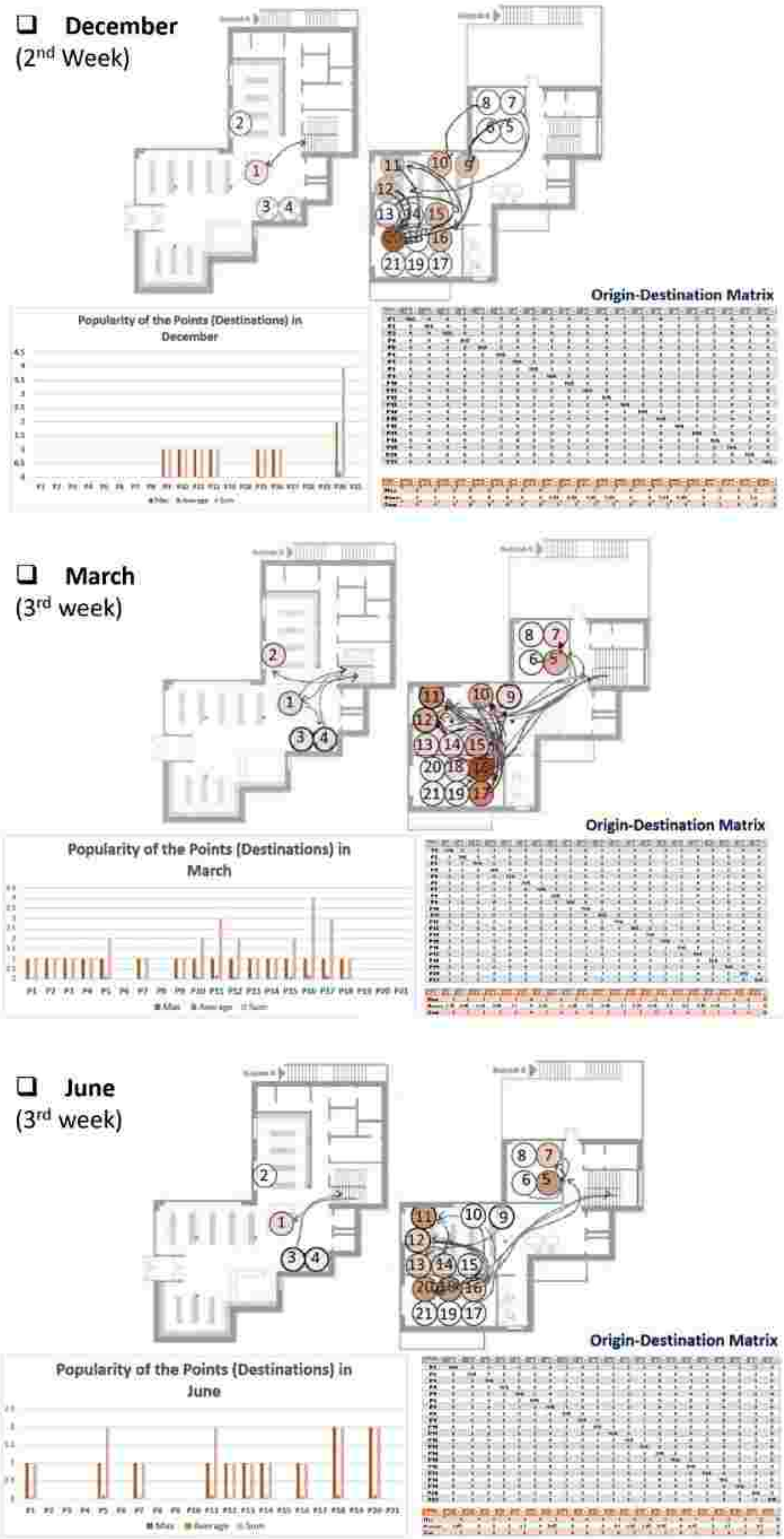


Figure 4.11. Movement Intensity in the Witomino library.

4.2.1. Spatial Efficacy and Movement Intensity Scores

This subsection explains the method used to score the statistics derived from the observations. The previously described behavior mapping is evaluated here to facilitate future data analysis and enable better integration with data from the simulations. The resulting scores for both libraries are provided in Appendix 6. Below the behavior maps presented in the previous section are charted for better comparisons.

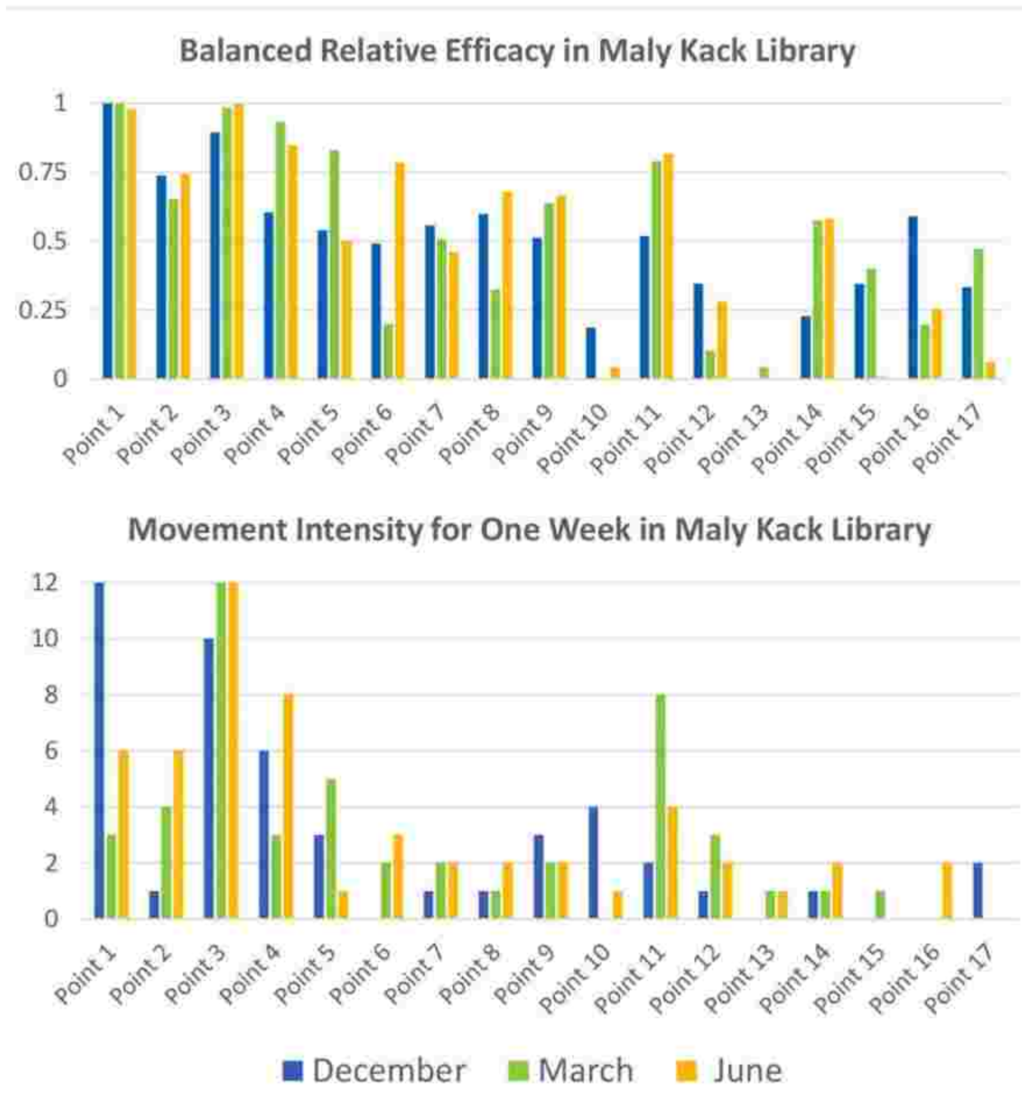


Figure 4.12. Statistical analysis of spatial efficacy and movement Intensity in Maly Kack library.

The spatial efficacy analysis reveals several key patterns in Maly Kack library (upper chart in Fig. 4.12). Point 1 stands out as an outlier in the daylighting study, primarily occupied due to its computer access rather than spatial or environmental qualities. Points 2 and 3 maintain stable efficacy levels across all seasons, with Point 2 demonstrating high efficacy and Point 3 consistently reaching very high values. A gradual increase in spatial efficacy from winter to summer is observed in Points 4, 9, 11, and 14, indicating improved environmental or user-perceived quality during warmer months. In contrast, Points 10 and 13 exhibit the lowest efficacy across all seasons, suggesting limited user preference or poor environmental performance. Notably, Point 14 shows a significant rise in efficacy over time, whereas Points 15, 16, and 17 display a downward trend from winter to summer. Additionally, Points 3 and 4 reinforce this seasonal pattern by showing an overall increase in spatial efficacy as conditions shift toward summer.

Moreover, the movement intensity analysis reveals distinct seasonal patterns in Maly Kack library (bottom chart in Fig. 4.12). Point 1, similar to the daylighting study, is identified as an outlier, as its occupation is primarily driven by computer access rather than spatial or environmental factors. Point 2 exhibits a clear and significant increase in movement intensity from winter to summer, suggesting a growing preference for or functional use of this location in warmer months. In contrast, Point 5 shows a decline in movement intensity over the same period. Conversely, Points 6, 7, and 8 demonstrate an upward trend in movement intensity from winter to summer, indicating enhanced user circulation or engagement with these areas during the later observation periods.

The spatial efficacy analysis highlights several distinct spatial usage patterns across seasons in Witomino library (upper chart in Fig. 4.13). Points 1, 2, 3, and 18 exhibit a significant and gradual increase in efficacy from winter to summer, suggesting a growing user preference or improved environmental conditions over time. Points 5, 14, 18, and 20 also show a gradual upward trend, though the increase is less pronounced compared to the former group. Consistent spatial use throughout all three observation periods is observed at Points 8, 9, and 21, indicating stable occupancy and reliable spatial performance. In contrast, a decline in occupancy - and thus efficacy - is noted at Points 11, 13, 16, 17, and 19, implying reduced user engagement or seasonal preference shifts. Notably, Points 20 and 12 demonstrate the highest spatial efficacy across all seasons, highlighting their sustained attractiveness or functional value within the environment.

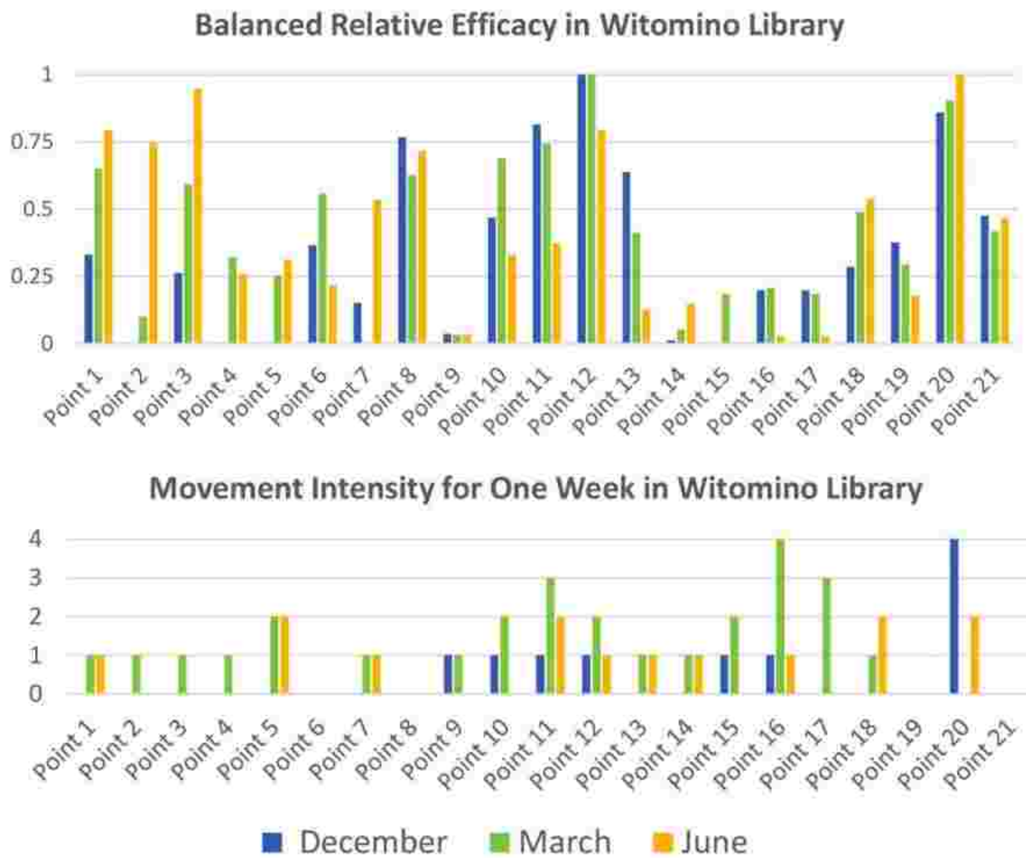


Figure 4.13. Statistical analysis of spatial efficacy and movement Intensity in Witomino library.

The movement intensity analysis reveals notable seasonal variations across different points in Witomino library (bottom chart in Fig. 4.13). Point 20 experienced the highest movement intensity during winter, but this significantly declined by summer, indicating a shift in user behavior or spatial preference. No movement activity was recorded at Points 1, 2, 3, 4, 5, 7, 13, 14, and 18 during the winter season; however, Points 1, 5, 7, 13, 14, and 18 showed movement activity in the spring and summer, suggesting a seasonal emergence in usage. Points 6, 8, 19, and 21 consistently showed no movement across all observation periods, indicating minimal or no user engagement with these locations. Seasonal peaks in movement intensity shifted throughout the year: while Point 20 was dominant in winter, Points 16, 17, and 11 were the most active during spring. In the summer season, the highest levels of movement were recorded at Points 5, 11, 18, and 20, reflecting a redistribution of spatial activity as environmental or behavioral conditions changed.

4.3. Performance-Based Analysis

In the previous two sections (4.1 and 4.2), both the perception-based (subjective) analysis and the empirical (mixed-method) analysis based on observations were thoroughly presented and described in detail. This section introduces the performance-based (objective) analysis, drawing on the simulations from Chapter 3 (Modeling and Simulations). These simulations were conducted using the AnnuOWL plugin for Rhino to assess daylighting conditions, and DepthmapX software to examine movement patterns through space syntax analysis at both urban and building scales.

4.3.1. Daylight Performance Analysis

AnnuOWL is a simulation tool used to analyze daylighting conditions, and in this research, it provides three key output metrics: Daylight Provision (DP), Glare Control, and Useful Daylight Illuminance (UDI) compliance. These metrics are essential for evaluating the quality and effectiveness of natural lighting in architectural spaces. The first two metrics - Daylight Provision and Glare Control - are presented through OVNI diagrams. Specifically, Daylight Provision is visualized in the central hemisphere of the OVNI, while Glare Control is displayed in the middle ring, oriented toward the four cardinal directions (see Methodology Section in the Introduction for details). Afterwards, using AnnuOWL, daylighting simulations were run for the selected case studies, as outlined before.

In the simulations through Annuwol, OVNI hemispheres are evaluated by classifying illuminance into Minimum (300–500 lux), Medium (500–750 lux), and High (>750 lux) ranges. For each occupied hour, a score of 1 is assigned if illuminance falls within the target range, otherwise 0. Scores are normalized over occupied hours, and if a category exceeds 50%, the gridpoint earns 1 point for that level. The final classification reflects the highest compliant category. Moreover, visual comfort is assessed using Daylight Glare Probability (DGP) at designated viewpoints across four orientations. DGP values are categorized as High (<0.43), Medium (0.43–0.45), and Minimum (0.45–0.47). A point is assigned if a category exceeds 95% of occupied hours. Viewpoints are classified based on the highest category achieved. Finally, for UDI simulations a threshold is defined by default with 100 lux as minimum and 2000 lux as maximum.

In this section, daylight sufficiency, along with other daylight metrics simulated using AnnuOWL—specifically UDI compliance and Glare Control—have been evaluated and scored. AnnuOWL applies a four-level color-coded scale to assess these metrics. For Daylight Provision (DP) and UDI compliance, the levels range from no compliance, low compliance, medium compliance, to high compliance.

Similarly, Glare Control is rated from no control, low control, medium control, to high control. Following this framework, the same four-point scale has been adopted in this research to rate the daylighting performance across the case studies. For a complete dataset detailing the evaluation at every measured point within the libraries, please refer to Appendix 7.

UDI Compliance and Daylight Provision Scores

The charts below represent Useful Daylight Illuminance (UDI) analysis and Daylight Provision analysis using AnnuOWL for Maly Kack library (upper chart in Fig. 4.14) and Witomino library (upper chart in Fig. 4.15).

UDI is defined as the percentage of time a point receives illuminance within the range of 100 to 2000 lux, considered suitable for typical visual tasks according to EN 17037 standard (European Committee for Standardization, 2019). In the simulation the grids were 0.8 square meters. Each grid point on the floor plan was assigned a performance score from 1 to 4, corresponding to UDI compliance levels:

- 1 - Non-compliant (Red)
- 2 - Minimum compliance (Orange)
- 3 - Moderate compliance (Yellow)
- 4 - High compliance (Green)

These categories reflect the extent to which each point meets daylight sufficiency standards over the simulation period. To assign a score to each seating point, the minimum compliance that fell within the seating point was selected to reflect the score of UDI compliance for that point.

In addition, the same charts mentioned above present daylight illuminance performance across OVNI hemispheres based on AnnuOWL simulation results for Maly Kack library (bottom chart in Fig. 4.14) and Witomino library (bottom chart in Fig. 4.15).

Illuminance values are categorized into three ranges: Minimum (300–500 lux), Medium (500–750 lux), and High (>750 lux). For each occupied hour, a value of 1 is assigned if the illuminance at a point falls within the specified range; otherwise, 0. These values are normalized over the total number of occupied hours. If a point meets the threshold for a given category in more than 50% of occupied hours, it is assigned a score as follows:

- 0 - Non-compliant (Red)
- 1 - Minimum compliance (Orange)
- 2 - Medium compliance (Yellow)
- 3 - High compliance (Green)

The final classification of each OVNI point reflects the highest category for which it qualifies, providing a clear visual representation of spatial daylight sufficiency in the hemisphere.

The daylighting analysis in Maly Kack (Fig. 4.14) reveals distinct spatial and seasonal patterns in daylight performance across the monitored points, evaluated using UDI metrics based on the OVNI method and aligned with the EN 17037 standard (European Committee for Standardization, 2019).

Points 1 and 11 consistently receive low levels of daylight (DP) throughout all seasons, with UDI values falling below the minimum threshold of 100 lux. This indicates a persistent lack of daylight sufficiency, suggesting the need for supplementary artificial lighting in these areas. In contrast, Point 13 frequently exceeds the upper boundary of the UDI comfort range (2000 lux), indicating conditions of over-illumination that may lead to visual discomfort or glare during peak daylight hours.

Points 3, 4, 5, 6, 7, 12, and 14 demonstrate a noticeable decline in UDI compliance from winter to summer. These points achieve very high compliance in winter and high compliance in spring; however, performance drops significantly in summer, reaching low or no compliance levels. Despite this reduction, Points 3 and 4 maintain adequate daylight provision throughout the year, even when UDI values fall below the recommended range in summer. This indicates that although the daylight may be outside the optimal range for task comfort, the overall light levels remain sufficient for general visual needs.

Point 11, while showing consistent underperformance in terms of daylight provision, surprisingly maintains UDI values within the acceptable range across all seasons. This suggests that although light levels are generally low, they remain stable and fall within the useful daylight window for a sufficient percentage of occupied hours.

Finally, Points 14, 15, 16, and 17, located within the same spatial zone, display significant seasonal variability. Points 14, 15 and 17 demonstrate decline in overall UDI compliance during winter to summer, with points 15, and 17 experiencing over-illumination during the summer, which reduces the usefulness of the daylight received and raises the potential for glare or thermal discomfort. In contrast, Point 16 is underlit in winter, with UDI values falling below recommended levels, but meets daylight sufficiency criteria during spring and later acceptable compliance during June, indicating improved solar exposure during the brighter months.

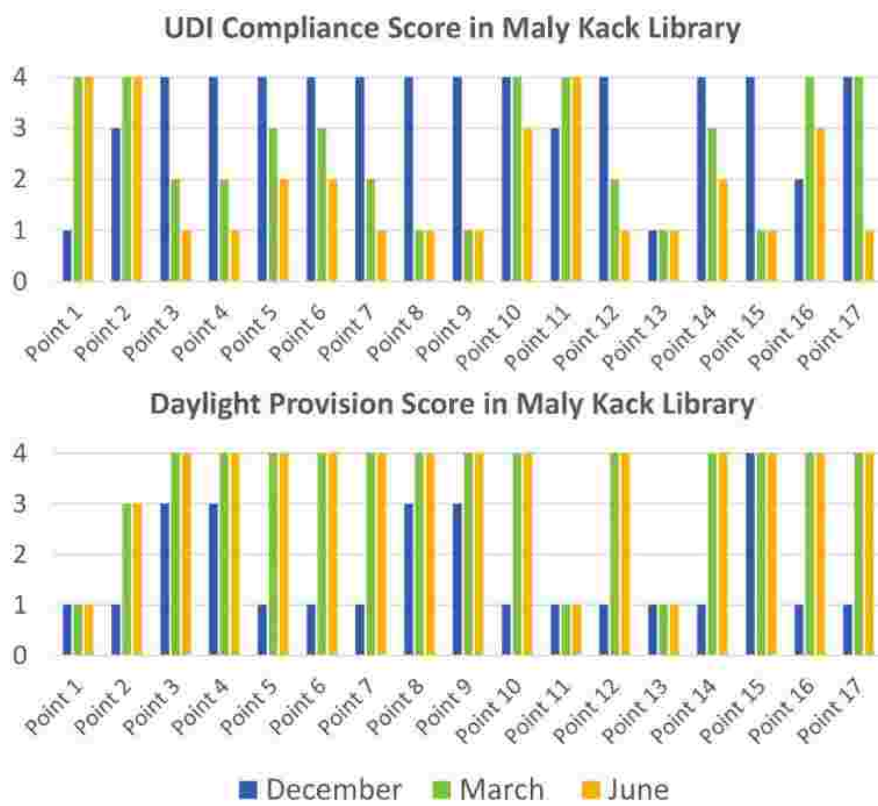


Figure 4.14. Daylighting scores in Maly Kack library.

The daylighting performance analysis for Witomino library (Fig. 4.15) reveals distinct variations in both seasonal and spatial patterns, assessed using the Useful Daylight Illuminance (UDI) and Daylight Provision.

Point 9 exhibits a dual daylighting condition: it is underlit during the winter season and over-illuminated in summer. However, it maintains overall adequacy in daylight provision, as confirmed by both UDI and DP scores across the year. Similarly, Points 1, 3, and 4 consistently display low DP SCORES across all seasons, indicating minimum daylight sufficiency, yet achieve acceptable UDI scores during spring and summer, suggesting the presence of useful daylight for a substantial portion of occupied hours during those periods.

Points 14, 16, 17, 18, and 19 demonstrate consistently high UDI performance throughout the year, indicating a stable and well-distributed daylight environment across all seasons.

In contrast, Points 1, 3, 4, 9, 13, and 15 are classified as underlit during winter according to UDI analysis, reflecting insufficient daylight exposure during this season.

Points 2, 7, 8, 10, 11, 12, 20, and 21 receive useful daylight levels in winter but exceed the upper UDI threshold during spring and summer, indicating potential over-illumination during those months. Despite this, their DP values in spring and summer remain within acceptable limits, suggesting that while UDI indicates excess daylight, the daylight sufficiency remains in a functional range.

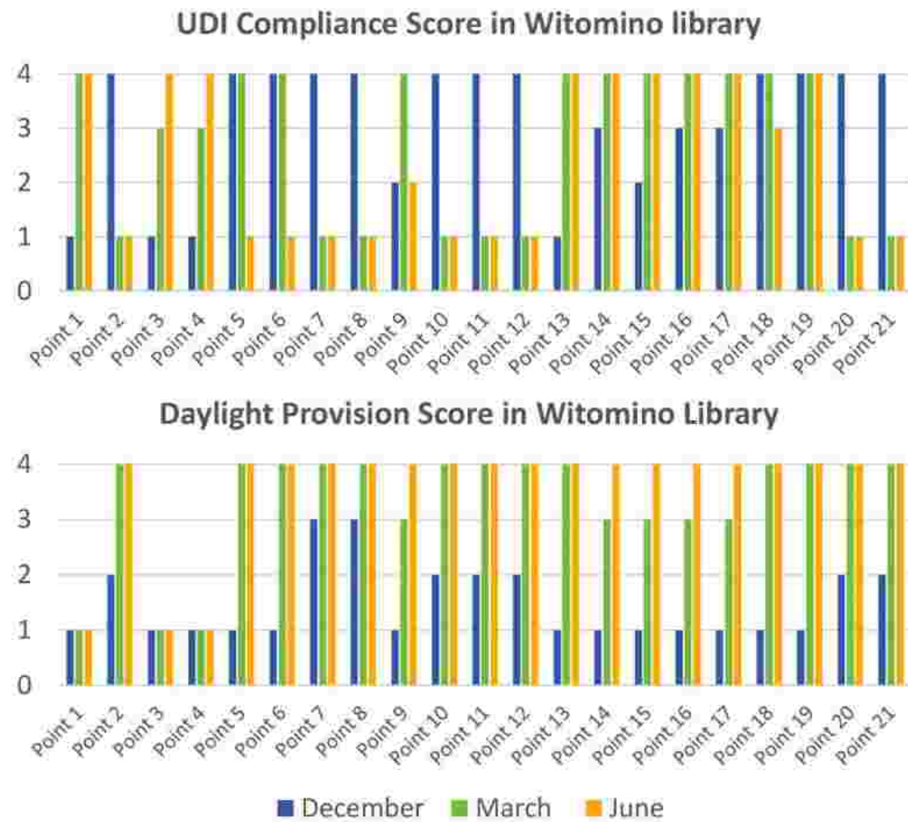


Figure 4.15. Daylighting scores in Witomino library.

Glare Control Scores

Visual comfort is evaluated using the Daylight Glare Probability (DGP) metric at designated viewpoints across four orientations. DGP values are categorized into three comfort levels based on established thresholds:

- 4 - High control (DGP < 0.43)
- 3 - Medium control (0.43 ≤ DGP < 0.45)
- 2 - Minimum control (0.45 ≤ DGP < 0.47)
- 1 - Non-compliant (DGP ≥ 0.47 or insufficient qualifying hours)

For each occupied hour, a value of 1 is assigned if the DGP falls within the range for a given comfort level; otherwise, 0. These values are normalized over the total number of occupied hours. If a DGP category is satisfied in more than 95% of the occupied hours, the viewpoint is awarded a point for that category. The final glare comfort classification for each viewpoint is determined by the highest category in which it qualifies.

In this study, the glare control level at each OVNI point was quantified using a scale from 1 to 4 in the four cardinal directions, as defined by the OVNI system (refer to the Appendix 7). To incorporate both overall visual comfort and sensitivity to extreme glare conditions, the average glare control score per point was calculated. A penalty of one point was applied if any directional glare control score indicated severe discomfort (score = 1). This method balances sensitivity to localized intense glare with a consistent aggregate measure of typical glare exposure. The penalty was applied only once per point to avoid over-penalization from multiple glare occurrences in different directions or times, thereby providing a realistic representation of occupant experience without introducing excessive bias.

The glare analysis for Maly Kack library (Fig. 4.16) reveals seasonal variations in visual comfort across the assessed points, based on directional glare conditions evaluated using the Daylight Glare Probability (DGP) metric.

Majority of the seating points except 1, 2, 11, and 17 exhibit elevated glare levels in at least one direction during the spring or summer seasons, indicating a potential for visual discomfort during peak daylight hours. These conditions suggest that while certain orientations at these points may remain comfortable, at least one directional exposure exceeds the tolerable threshold for glare under specific seasonal lighting conditions.

Points 10, although generally characterized by low glare levels throughout the year, registers intolerable glare from at least one direction in both spring and summer. This indicates a context-dependent visual challenge that may not be reflected in overall averages but could affect user experience during critical times.

All points are classified as glare-free during the winter season, reflecting stable and visually comfortable conditions across all orientations during that period.

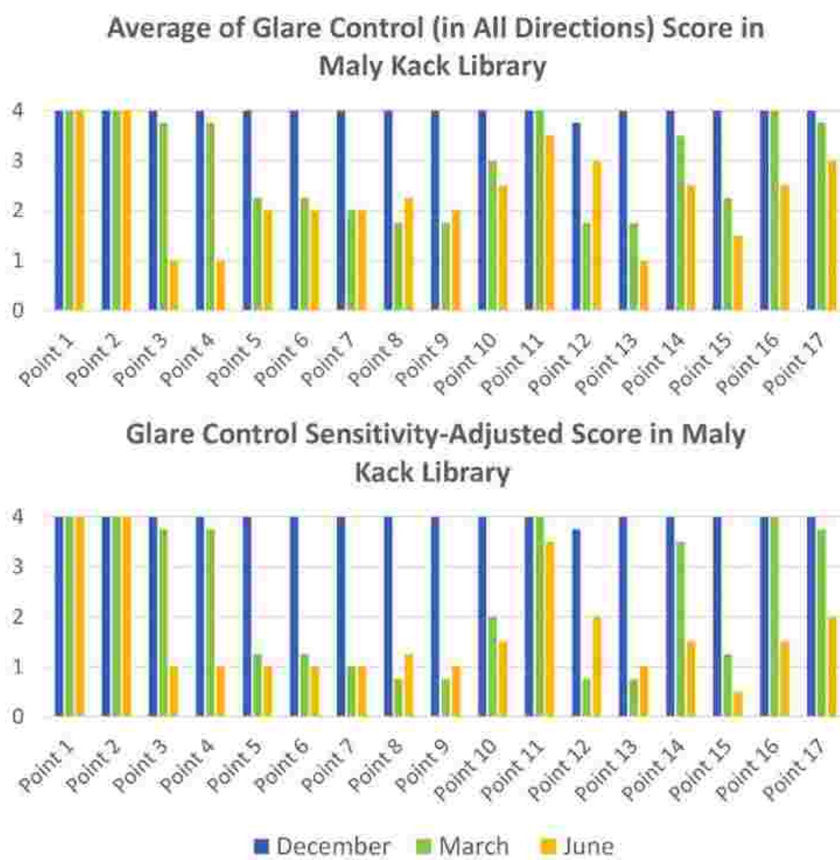


Figure 4.16. Glare control scores in Maly Kack library.

The glare analysis for Witomino library (Fig. 4.17), based on Daylight Glare Probability (DGP) evaluations at multiple orientations, indicates clear seasonal variability in visual comfort across the analyzed viewpoints.

Points 2, 5, 6, 7, 8, 10, 11, 12, 20, and 21 exhibit elevated glare levels from at least one direction during the spring and summer seasons. These conditions suggest a higher potential for visual discomfort during periods of increased solar exposure, particularly in spaces with direct or oblique sunlight penetration.

In contrast, all evaluated points are classified as glare-free during the winter months, reflecting consistently low DGP values and stable visual comfort across all orientations in that season.

Points 13 and 14 experience high glare levels during spring but show minimal glare in both summer and winter. This pattern suggests that their exposure to direct sunlight is more pronounced during the mid-year solar angle transitions, while shading or spatial geometry may help mitigate glare in other seasons.

Points 1, 3, 4, and 15 remain completely glare-free throughout the year. Their stable performance across all seasons indicates that these positions maintain favorable orientation, spatial configuration, or effective shading strategies that prevent glare under varying daylight conditions.

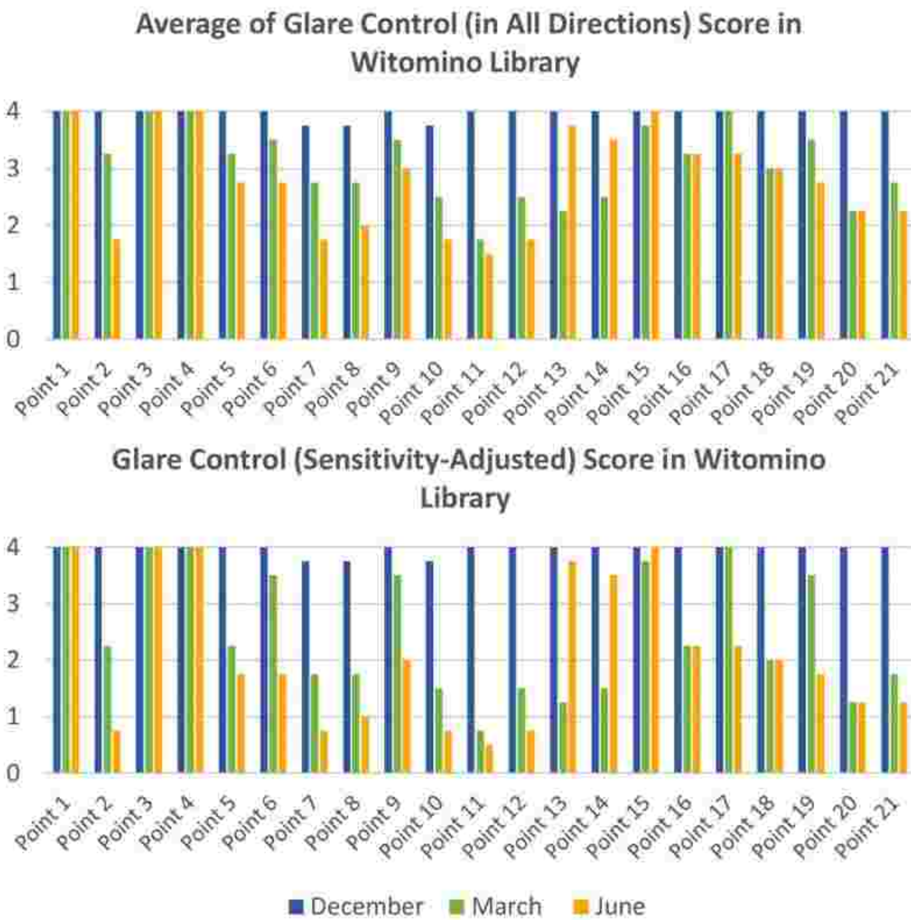


Figure 4.17. Glare control scores in Witomino library.

4.3.2. Movement Patterns Analysis

In the Introduction (refer to Appendix 1) the methodology for retrieving movement pattern data through space syntax analysis using DepthmapX was introduced. Subsequently, in Section 3.2 of Chapter 3, visibility and connectivity values for both libraries were computed following the methodology outlined in the aforementioned section.

In this section, the seating points in both libraries are evaluated and scored based on the spatial patterns of movement, derived from the visibility and connectivity values obtained through space syntax analysis (see figures in Section 3.2 of Chapter 3). The scoring methodology is guided by the following logic:

I. A four-point scale is employed to classify each seating point, representing levels of spatial integration as follows: 1 - Low, 2 - Medium, 3 - High, and 4 - Very High visibility or connectivity. This scale has been adopted to ensure consistency with the four-point scoring systems used for daylighting analysis via AnnuOWL simulations and for behavioral data, thereby facilitating the correlation of all datasets in the final analysis.
II. The highest value of either the connectivity line or visibility cell that intersects a given seating point is assigned as that point's score. This approach assumes that a seating point is functionally integrated within the space if it is highly connected or visible from at least one direction, reflecting potential for spatial awareness and accessibility.

After scoring both of the metrics for both of the libraries two tables were created to present the movement pattern scores for each of the libraies (refer to Appendix 8).

The space syntax analysis for Maly Kack library (Fig. 4.18) reveals varying degrees of spatial integration across the seating points, as measured by visibility and connectivity values.

Point 1 records the lowest scores in both visibility and connectivity, indicating a spatially isolated position with limited visual and physical access. Points 2, 9, 11, 16, and 17 demonstrate high connectivity but comparatively lower visibility, suggesting that while these locations are well integrated into circulation routes, they are not prominently visible within the spatial layout. Notably, Points 2 and 9 stand out by combining the highest connectivity scores with the lowest visibility, potentially reflecting functionally central yet visually discreet seating areas.

Points 3 and 4 exhibit high scores in both visibility and connectivity, indicating strong spatial integration and visibility within the layout. Meanwhile, Points 5, 6, 7, 8, 10, 12, 13, 14, and 15 display very high values in both metrics, highlighting their positions as spatially prominent and likely to be perceived as central or accessible locations within the library environments.

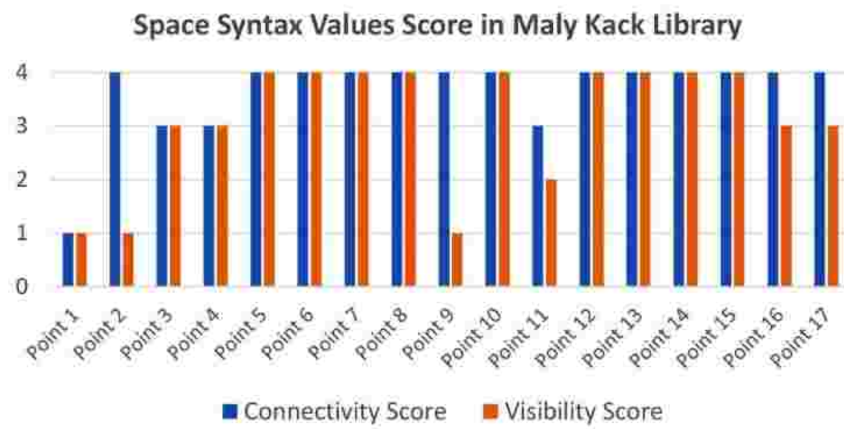


Figure 4.18. Movement pattern scores in Maly Kack library.

The space syntax analysis for Witomino library (Fig. 4.19) reveals a diverse range of spatial integration levels across the evaluated seating points, based on their visibility and connectivity scores.

Point 1 demonstrates very high scores in both connectivity and visibility, indicating a spatially prominent and well-integrated location. Point 20 also shows high connectivity and visibility, reflecting a similarly accessible and visually exposed position within the layout.

In contrast, Points 5, 6, 7, and 8 receive the lowest scores for both metrics, signifying minimal spatial integration and limited visual access. These positions are likely to be more secluded within the spatial configuration.

Points 2, 3, 4, 9, 10, 11, 12, 13, 14, and 15 exhibit higher connectivity values but lower visibility scores, suggesting that while these points are well connected to circulation paths, they are less visually prominent within the overall spatial field.

Conversely, Points 16, 17, 18, 19, and 21 show lower connectivity in comparison to their visibility scores, indicating that these locations are more visually exposed than they are functionally connected to movement flows.

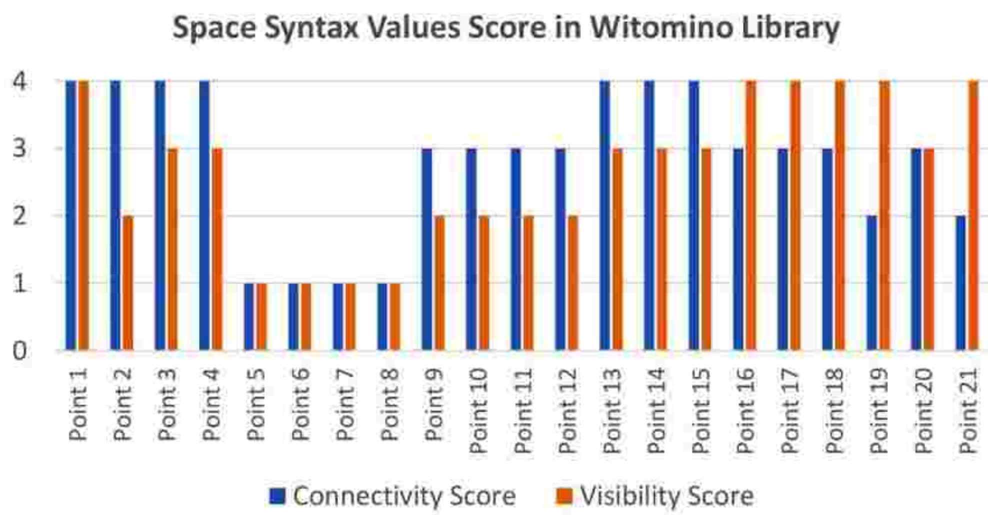


Figure 4.19. Movement pattern scores in Maly Kack library.

4.4. Data Synthesis

In this section, the analyzed data in the previous sections of this chapter will be integrated together to uncover correlations between different perceptual, empirical and performance-based values. So far, the data collected, wangled, and transformed from different sources could shape the statistical data layers presented below (Table 4.2).

Table 4.2. Data Layers.

Category	**Analysis level**	**Feature**	**Data source**	**Tool**
Spatial	Grid level	Angular Segment Analysis (Connectivity)	Computation	Space syntax analysis with DepthmapX
	Grid level	Visibility Graph Analysis (Visibility)	Computation	Space syntax analysis with DepthmapX
Occupancy	Seat level	Seat efficacy (occupancy counts and duration)	Observation and calculation	Seat utilization index from observation sheets
	Seat level	Movement Intensity	Observation	Relocation presentation from observation sheets

User preference	Seat level	User-percieved and observed spatial characteristics of the seating points	Questionnaire and observation	User questionnaires and photography
	Seat level	Preferred locations	Questionnaire	Question 1 from user questionnaire
Environmental	Seat level	OVNI diagrams: glare compliance and daylight sufficiency	Simulation	Daylighting analysis with AnnuOWL plugin for Grasshopper
	Grid level	UDI compliance	Simulation	Daylighting analysis with AnnuOWL plugin for Grasshopper

4.4.1. Performance-Behavioral Data Integration

In this subsection, four datasets will be compared to explore potential relationships between empirical observational data and simulation-based data related to UDI, Connectivity, Spatial Efficacy, and Movement Intensity. UDI and Connectivity represent objective, simulation-derived metrics obtained through daylighting simulations and space syntax analysis, respectively. In contrast, Spatial Efficacy and Movement Intensity are based on empirical observations of user behavior within the space.

A key question arises here: Is daylighting or spatial connectivity a more significant determinant of spatial efficacy and movement Intensity? To begin addressing this, the following figures present daylighting simulation results overlaid with behavioral data for both libraries. Figures 4.20 and 4.21 show the results for Spatial Efficacy compared to UDI in both libraries, while Figures 4.22 and 4.23 depict Movement Intensity compared to UDI for both Libraries.

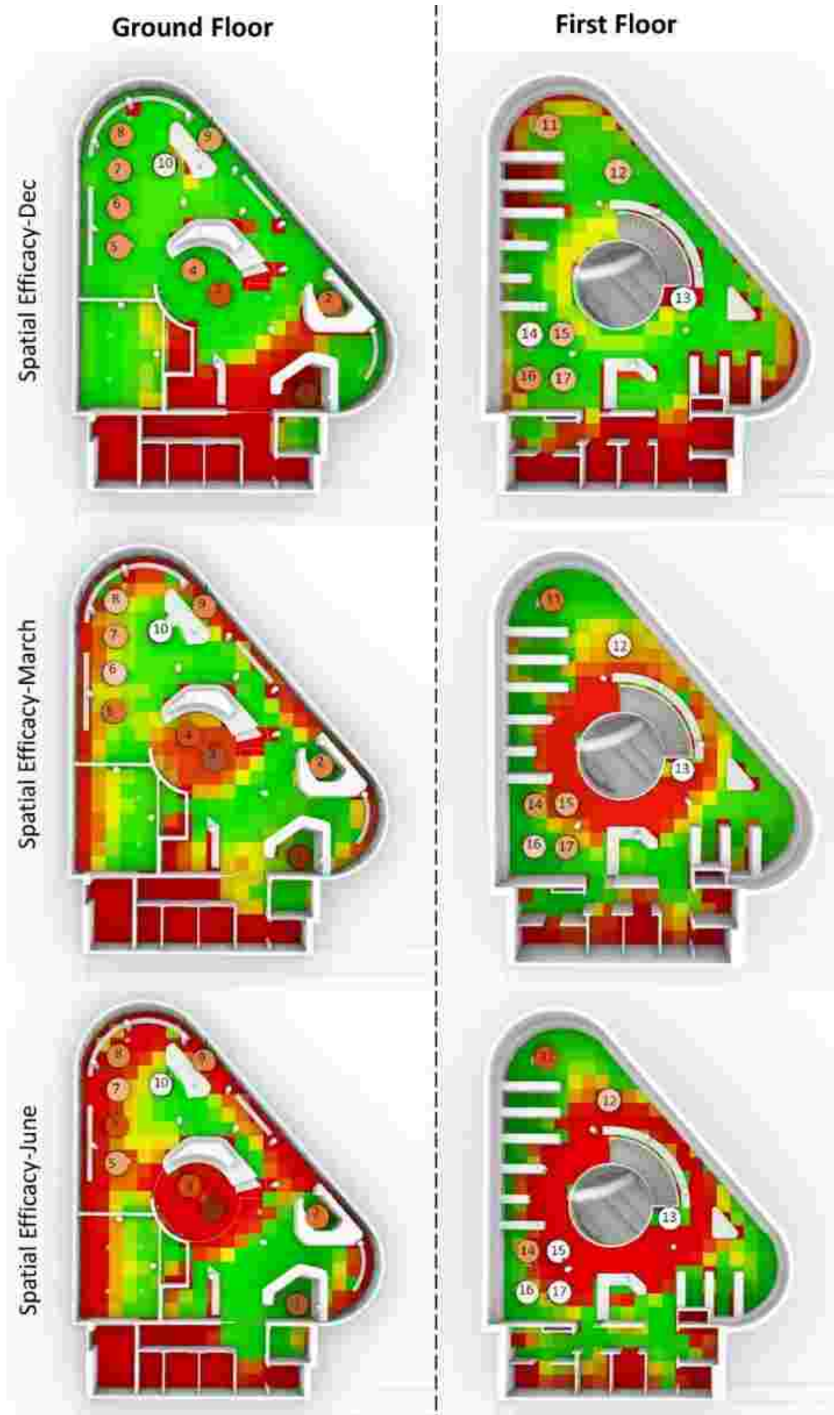


Figure 4.20. Spatial efficacy overlaid on UDI simulation results for the Maly Kack Library.

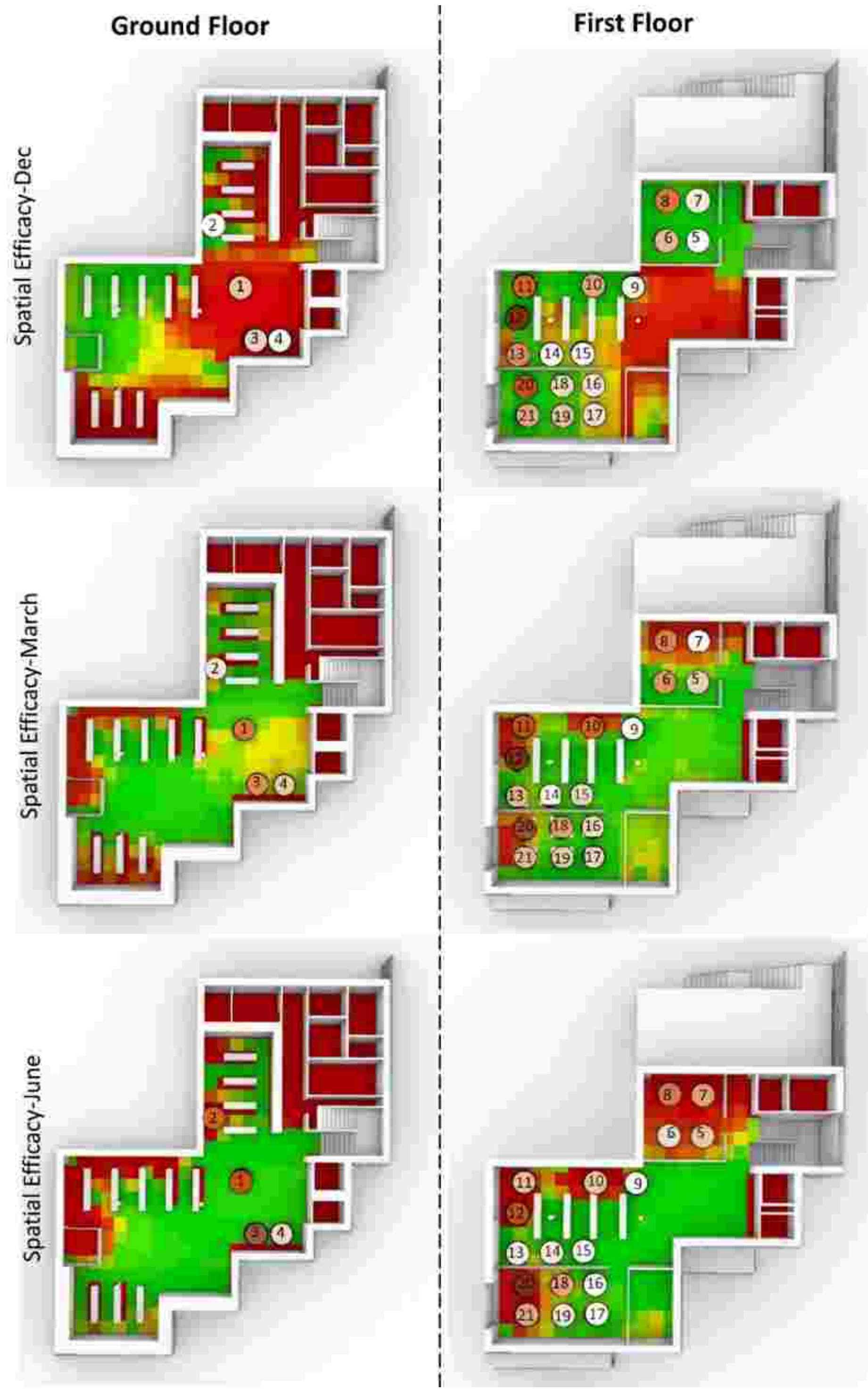


Figure 4.21. Spatial Efficacy overlaid on the UDI simulation in Witomino library.

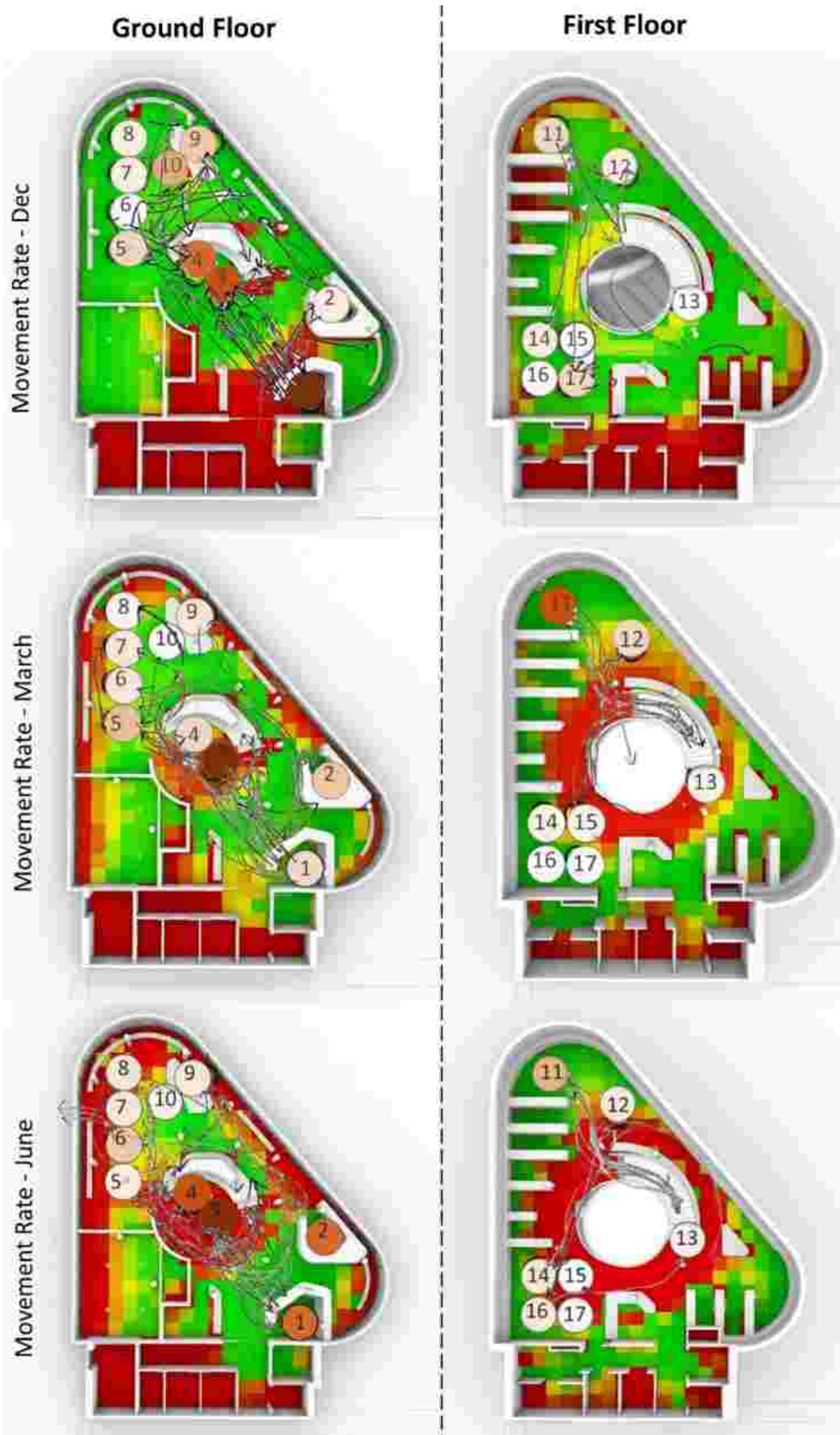


Figure 4.22. Movement Intensity overlaid on the UDI simulation in Maly Kack library.

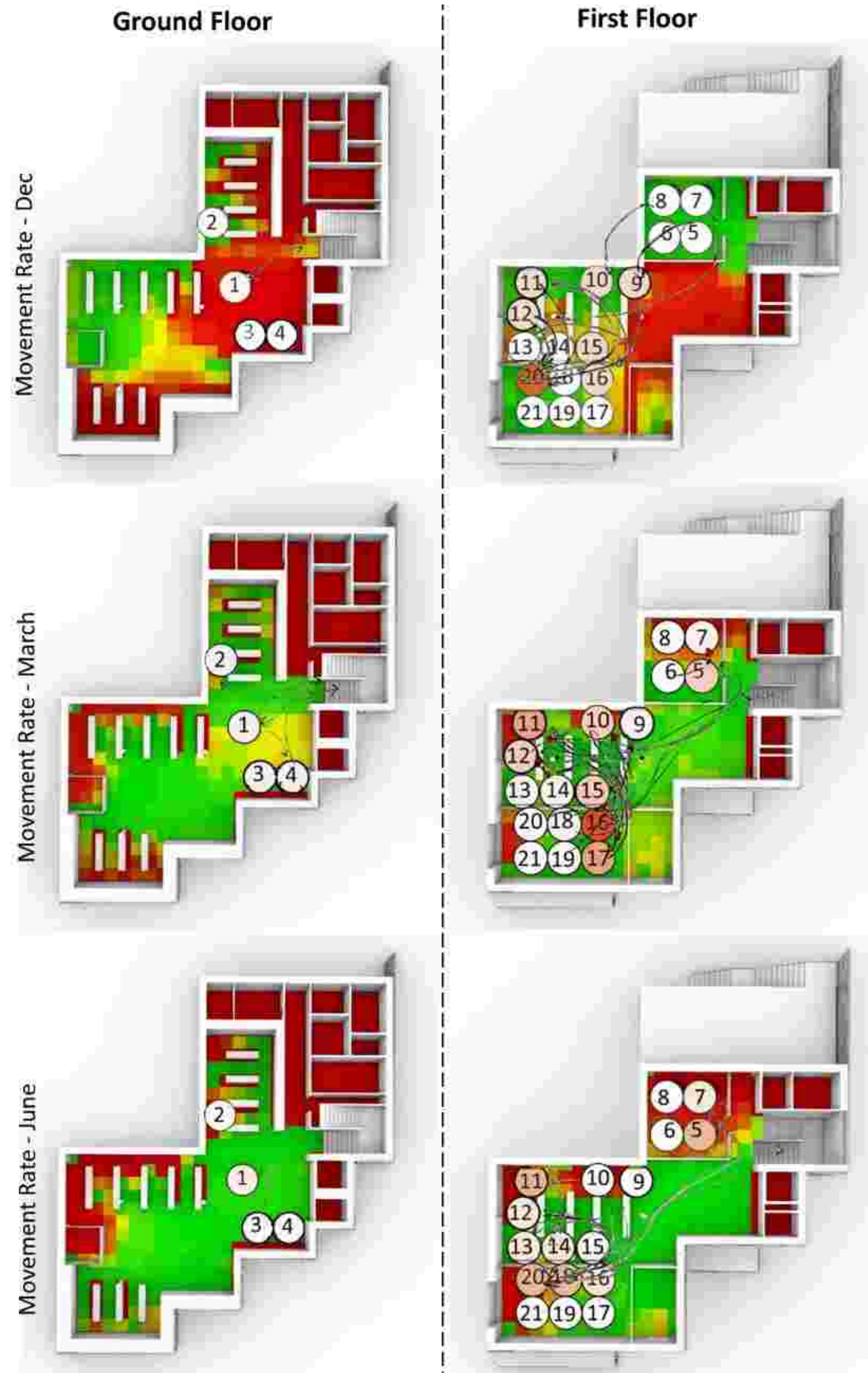


Figure 4.23. Movement Intensity overlaid on the UDI simulation in Witomino library.

According to the visualization above, there is evidence that daylighting influences user behavior in certain areas. For instance, in the Maly Kack Library, points 5, 6, 7, and 8 - located within the same zone and sharing identical seating characteristics and daylighting strategies - show similar levels of spatial efficacy in December (Fig. 4.20). This suggests a uniform use of space across these seating points, likely due to the more diffused and evenly distributed daylight typical of winter. However, in other seasons, the use of these same seating areas varies more noticeably, reflecting the changing daylight conditions throughout the day and indicating a stronger spatial preference driven by light quality and orientation.

However, behavioral patterns in some areas remain relatively consistent, even as UDI compliance improves or declines between December and June - for example, points 2, 3, 4, and 9 in the Maly Kack Library (Fig. 4.20), and points 12 and 20 in the Witomino Library (Fig. 4.21). This suggests that daylighting conditions alone may not fully explain spatial usage patterns. In these cases, other factors - such as spatial configuration and connectivity - may play a more influential role.

According to the movement Intensity analysis in Maly Kack, movement toward Point 2 gradually increased from December to June, corresponding with improvements in UDI, particularly in daylight provision. In contrast, movement toward Point 9 - the only point visible from Point 2 - gradually declined over the same period (Fig. 4.22).

To explore these further, behavioral scores are overlaid onto the static connectivity values, aiming to uncover underlying patterns shaped more by spatial structure than by daylight availability. Visualizations below compare the behavior mapping with connectivity values (Figures 4.24, 4.25, 4.26, and 4.27).

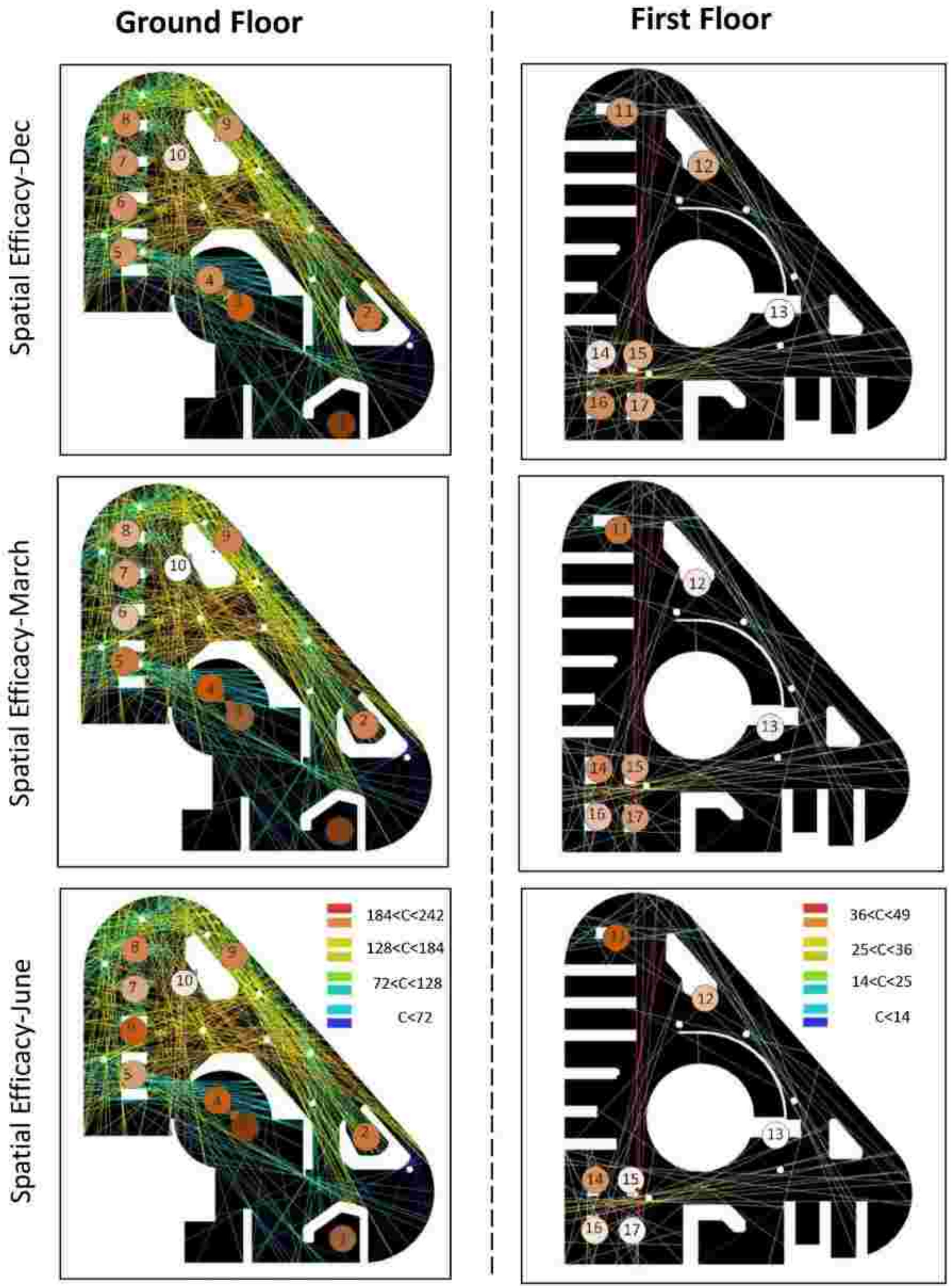


Figure 4.24. Spatial Efficacy overlaid on the Connectivity Analysis in Maly Kack library.

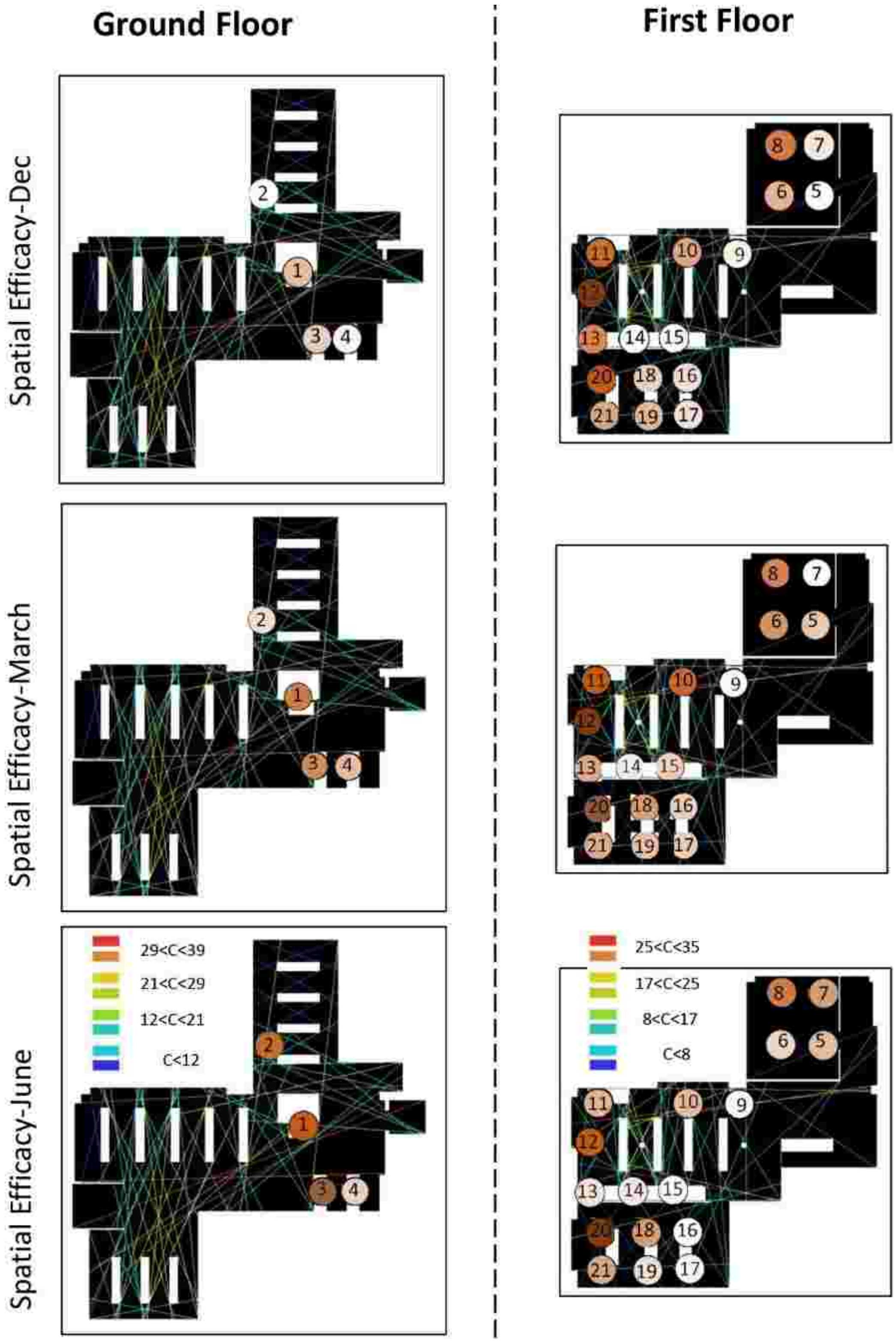


Figure 4.25. Spatial Efficacy overlaid on the Connectivity Analysis in Witomino library.

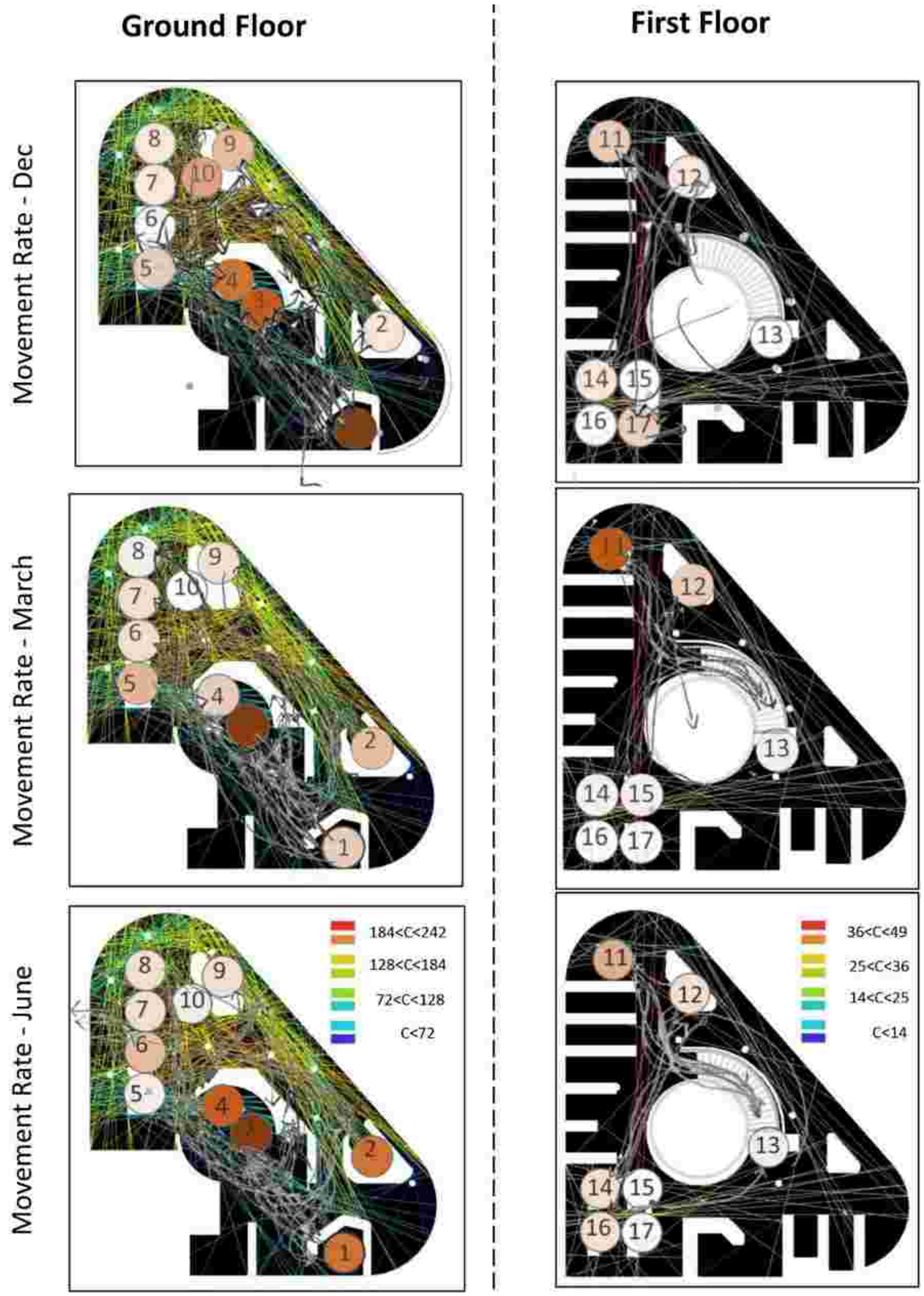


Figure 4.26. Movement Intensity overlaid on the Connectivity Analysis in Maly Kack library.

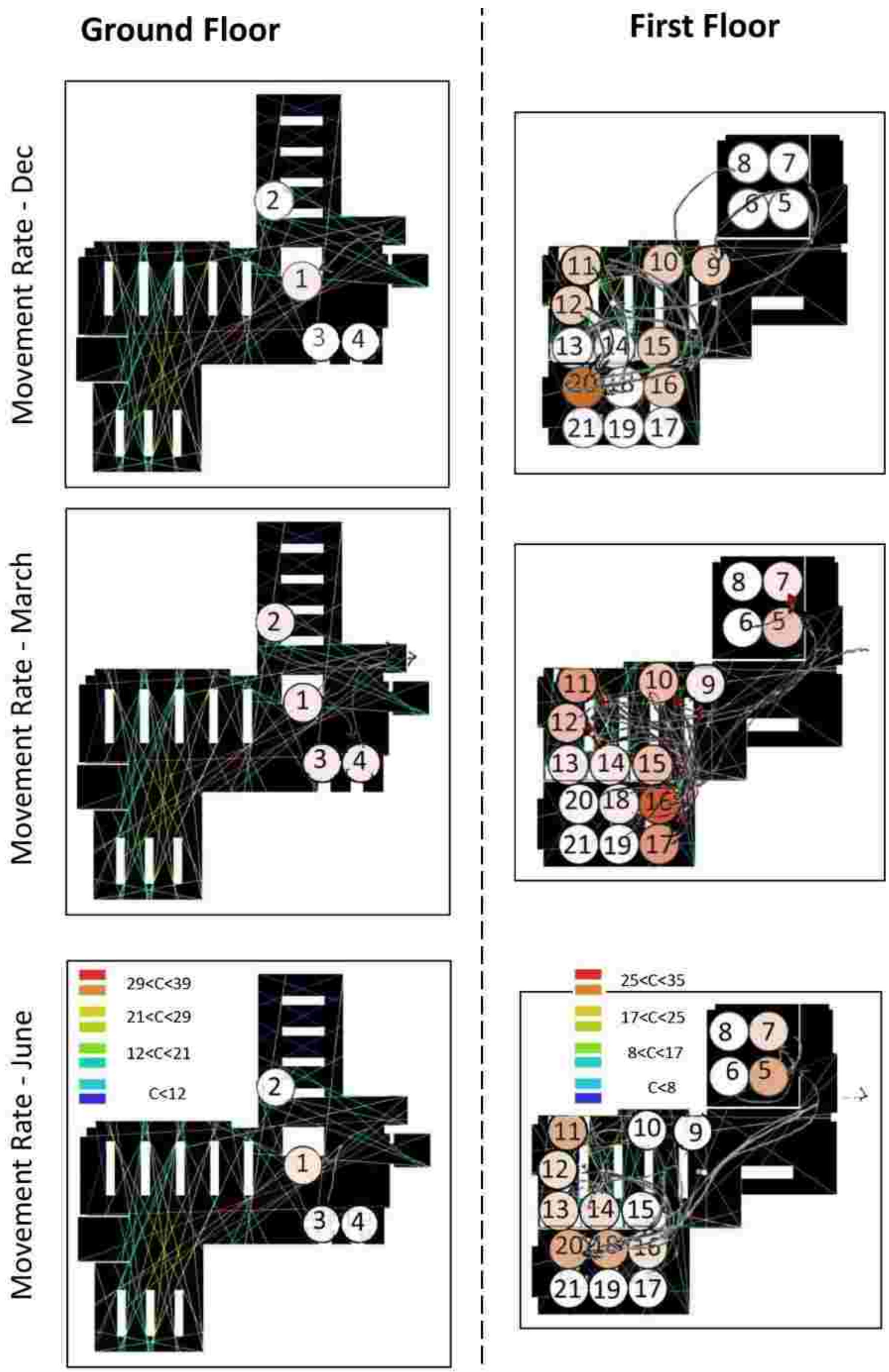


Figure 4.27. Movement Intensity overlaid on the Connectivity Analysis in Witomino library.

All in all, the comparison of spatial efficacy and movement intensity with connectivity values and UDI grid indicates that spatial efficacy remains relatively static at certain points - such as 8, 12, 19, 20, and 21 in Witomino, and 1, 2, 3, 4, 9, and 11 in Maly Kack - which are characterized by higher numbers of lines with low to medium connectivity. In contrast, movement intensity appear to be more influenced by dynamic building attributes, such as daylighting condition, rather than static factors like spatial layout.

4.4.2. Heatmap and Correlation Matrix

All variables retrieved from each data source (refer to Table 4.2) have been abbreviated to create a more concise dataset, enabling faster visual analysis (Table 4.3).

Table 4.3. Data variables and their abbreviation in this research.

Variable	Abbr.	Variable	Abbr.
Connectivity	**VIS**	Useful Daylight Illuminance in June	**UDI-J**
Visibility	**CON**	Daylight Provision in December	**DP-D**
Glare (Sensitive) Control in December	**GSC-D**	Daylight Provision in March	**DP-M**
Glare (Sensitive) Control in March	**GSC-M**	Daylight Provision in June	**DP-J**
Glare (Sensitive) Control in June	**GSC-J**	Movement Intensity in December	**MI-D**
Glare Control Average in December	**GCA-D**	Movement Intensity in March	**MI-M**
Glare Control Average in March	**GCA-M**	Movement Intensity in June	**MI-J**
Glare Control Average in June	**GCA-J**	Spatial Efficacy December	**SE-D**
Useful Daylight Illuminance in December	**UDI-D**	Spatial Efficacy March	**SE-M**
Useful Daylight Illuminance in March	**UDI-M**	Spatial Efficacy June	**SE-J**

The initial heatmaps for each library are presented in two separate tables: one for Maly Kack (Fig. 4.20) and one for Witomino (Fig. 4.21). Each table displays a color-coded visualization of the evaluation scores, ranging from good to poor, across all seating points and variables in the study. These scores are derived from the scoring of various data layers presented in the previous sections, including space syntax analysis, behavioral observations, and simulation-based analysis.

	Seating Points																
Variables	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
CON	1	4	3	3	4	4	4	4	4	4	3	4	4	4	4	4	4
VIS	1	1	3	3	4	4	4	4	1	4	2	4	4	4	4	3	3
GSC-D	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4
GSC-M	4	4	4	4	1	1	1	1	1	2	4	1	1	4	1	4	4
GSC-J	4	4	1	1	1	1	1	1	1	2	4	2	1	2	1	2	2
GCA-D	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4
GCA-M	4	4	4	4	2	2	2	2	2	3	4	2	2	4	2	4	4
GCA-J	4	4	1	1	2	2	2	2	2	3	4	3	1	3	2	3	3
UDI-D	1	3	4	4	4	4	4	4	4	4	3	4	1	4	4	2	4
UDI-M	4	4	2	2	3	3	2	1	1	4	4	2	1	3	1	4	4
UDI-J	4	4	1	1	2	2	1	1	1	3	4	1	1	2	1	3	1
DP-D	1	1	3	3	1	1	1	3	3	1	1	1	1	1	4	1	1
DP-M	1	3	4	4	4	4	4	4	4	4	1	4	1	4	4	4	4
DP-J	1	3	4	4	4	4	4	4	4	4	1	4	1	4	4	4	4
MI-D	4	1	4	3	2	0	1	1	2	2	1	1	0	1	0	0	1
MI-M	2	2	4	2	2	1	1	1	1	0	3	2	1	1	1	0	0
MI-J	3	3	4	3	1	2	1	1	1	1	2	1	1	1	0	1	0
SE-D	4	3	4	3	3	2	3	3	3	1	3	2	1	1	2	3	2
SE-M	4	3	4	4	4	1	3	2	3	1	4	1	1	3	2	1	2
SE-J	4	3	4	4	3	4	2	3	3	1	4	2	1	3	1	2	1

Figure 4.20. Scoring heatmap in Maly Kack library.

	Seating Points																				
Variables	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21
CON	4	4	4	4	1	1	1	1	3	3	3	3	4	4	4	3	3	3	2	3	2
VIS	4	2	3	3	1	1	1	1	2	2	2	2	3	3	3	4	4	4	4	3	4
GSC-D	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4
GSC-M	4	2	4	4	2	4	2	2	4	1	1	2	1	1	4	2	4	2	4	1	2
GSC-J	4	1	4	4	2	2	1	1	2	1	1	1	4	4	4	2	2	2	2	1	1
GCA-D	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4
GCA-M	4	3	4	4	3	4	3	3	4	3	2	3	2	3	4	3	4	3	4	2	3
GCA-J	4	2	4	4	3	3	2	2	3	2	2	2	4	4	4	3	3	3	3	2	2
UDI-D	1	4	1	1	4	4	4	4	2	4	4	4	1	3	2	3	3	4	4	4	4
UDI-M	4	1	3	3	4	4	1	1	4	1	1	1	4	4	4	4	4	4	4	1	1
UDI-J	4	1	4	4	1	1	1	1	2	1	1	1	4	4	4	4	4	3	4	1	1
DP-D	1	2	1	1	1	1	3	3	1	2	2	2	1	1	1	1	1	1	1	2	2
DP-M	1	4	1	1	4	4	4	4	3	4	4	4	4	3	3	3	3	4	4	4	4
DP-J	1	4	1	1	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4
MI-D	0	0	0	0	0	0	0	0	1	1	1	1	0	0	1	1	0	0	0	4	0
MI-M	1	1	1	1	2	0	1	0	1	2	3	2	1	1	2	4	3	1	0	0	0
MI-J	1	0	0	0	2	0	1	0	0	0	2	1	1	1	0	1	0	2	0	2	0
SE-D	2	1	2	1	1	2	1	4	1	2	4	4	3	1	1	1	1	2	2	4	2
SE-M	3	1	3	2	2	3	1	3	1	3	3	4	2	1	1	1	1	2	2	4	2
SE-J	4	3	4	2	2	1	3	3	1	2	2	4	1	1	1	1	1	3	1	4	2

Figure 4.21. Scoring heatmap in Witomino library.

Based on the evaluation scores assigned to each seating point - drawn from multiple data layers such as space syntax analysis, behavioral observations, and simulation-based analysis - a ranking was generated for each variable using Excel. This ranking process was applied column-wise, assigning ordinal ranks to the scores in order to normalize the data for correlation analysis. Using these ranked values, a Spearman correlation matrix was then constructed and visualized as a heatmap, allowing for the identification of monotonic relationships between variables across the different seating points. Refer to the Excel file (Appendix 9) for a detailed explanation of the ranking process and correlation calculations. In other words, due to the integration of simulation outputs, spatial analysis, and observational data, variables were first standardized into comparable ordinal scales to ensure consistency across datasets. Subsequently, all variables were transformed into ranked values using the RANK.AVG function in Excel. This step was necessary to support the application of Spearman's rank correlation, which assesses relationships based on the relative ordering of values rather than their absolute magnitude. Next, the CORREL function in Excel was applied to the ranked datasets to generate the correlation matrix, allowing relationships between environmental, spatial, and behavioral variables to be assessed based on their relative ordering

Below the correlation heatmap for both Maly Kack library (upper matrix in Fig. 4.22) and Witomino library (Bottom matrix in Fig. 4.22). In the correlation matrix heatmap, a color-coding rule was applied to visually represent the strength and direction of the relationships between variables. Correlation values greater than 0.7 were colored dark green, indicating a strong positive correlation. Values between 0.5 and 0.7 were shown in green to represent a moderate positive correlation, while values from 0.3 to 0.5 were displayed in light green, indicating a weak to moderate positive correlation. The same logic was applied to negative correlations: values less than -0.7 were colored dark red (strong negative correlation), values between -0.5 and -0.7 were light red (moderate negative correlation), and values from -0.3 to -0.5 were shown in yellow, representing a weaker negative correlation.

❑ **Maly Kack library**

Variables	CON	VIS	GSC-D	GSC-M	GSC-J	GCA-D	GCA-M	GCA-J	UDI-D	UDI-M	UDI-J	DP-D	DP-M	DP-J	MI-D	MI-M	MI-J	SE-D	SE-M	SE-J
	Syntax		**Daylight**												**Behavior**					
CON		0.54		-0.55541	-0.203		-0.555408	-0.0368	0.29197	-0.20263	-0.224	-0.178	0.4196	0.42	-0.606	-0.6687	[illegible]	-0.618	-0.608	-0.7
VIS				-0.62953	-0.4609		-0.62953	-0.1825	0.45077	-0.38412	-0.383	-0.074	0.4378	0.438	-0.409	-0.3275	-0.498	-0.625	-0.497	-0.44
GSC-D																				
GSC-M																0.2259			0.4117	
GSC-J																	0.217			0.102
GCA-D																				
GCA-M																0.2259			0.4117	
GCA-J																	0.043			0.026
UDI-D															0.1889			-0.199		
UDI-M																-0.0429			0.0928	
UDI-J																	0.388			0.309
DP-D															0.2048			0.2727		
DP-M																-0.3796			-0.221	
DP-J																	-0.366			-0.22

❑ **Witomino library**

Variables	CON	VIS	GSC-D	GSC-M	GSC-J	GCA-D	GCA-M	GCA-J	UDI-D	UDI-M	UDI-J	DP-D	DP-M	DP-J	MI-D	MI-M	MI-J	SE-D	SE-M	SE-J
	Syntax		**Daylight**												**Behavior**					
CON		0.4		0.207633	[illegible]		0.207633	[illegible]	[illegible]	0.18057	[illegible]	-0.409	-0.3851	-0.497	0.0054	0.1078	-0.15	-0.125	-0.153	0.005
VIS				0.286576	[illegible]		0.286576	[illegible]	-0.3814	0.38468	[illegible]	-0.452	-0.4078	-0.244	-0.081	0.0308	-7E-04	-0.068	-0.183	-0.14
GSC-D																				
GSC-M																0.0135			-0.284	
GSC-J																	-0.155			-0.27
GCA-D																				
GCA-M																0.0135			-0.284	
GCA-J																	-0.155			-0.27
UDI-D															0.0078			0.3135		
UDI-M																0.134			-0.415	
UDI-J																	-0.156			-0.39
DP-D															0.218			0.4137		
DP-M																-0.2514			0.2798	
DP-J																	0.161			-0.25

Figure 4.22. Spearman Correlation Matrices for Maly Kack (top) and Witomino (bottom).

Connectivity (CON) and visibility (VIS) are moderately positively correlated (approximately 0.54 in Maly Kack and 0.4 in Witomino), reflecting their close spatial relationship. This association is stronger in the open-plan layout of Maly Kack, where fewer physical barriers allow visual access across more connected spaces.

One of the significant overall findings is that spatial configuration (open vs. segmented layout) could fundamentally changes how daylight conditions relate to spatial performance and user behavior. The correlation analysis between spatial syntax variables (connectivity and visibility) and glare control metrics across different months reveals patterns shaped by both layout and daylighting design. In the Maly Kack library - an open-plan layout with darker, less transparent glazing on the ground floor (except the south-facing side) and skylights on the first floor (which lacks vertical windows) - both connectivity and visibility show negative correlations with glare control levels in December, March, and June. These correlations range from weak (around -0.03) to moderate or strong (up to approximately -0.63), with March and especially June showing stronger negative relationships.

This could indicate that in the open-plan environment, areas that are more spatially integrated tend to experience poorer glare control, while more isolated zones provide better visual comfort. These less integrated areas are likely positioned further from direct daylight sources such as skylights or south-facing glazing. Seasonal variation could strengthen this effect, particularly in transitional months when sun angles and daylight intensity increase glare risk. In contrast, the Witomino library - with a segmented layout and large transparent windows on most orientations - exhibits weaker or slightly positive correlations between glare control and spatial properties. Here, glare control appears more evenly distributed across connected spaces, suggesting that segmentation and multi-directional daylight access moderate extreme glare effects.

When examining UDI (Useful Daylight Illuminance), clear seasonal changes emerge, particularly in relation to layout type. In Maly Kack, visibility shows a moderate positive correlation with UDI in December, but this shifts to a moderate negative correlation in March and July. This suggests that in winter, visually integrated areas benefit from limited daylight, whereas in brighter seasons, increased exposure may reduce useful daylight levels due to over-illumination. In contrast, Witomino presents the opposite tendency. In December, UDI is negatively correlated with connectivity and visibility, but in March and June these relationships become moderately to strongly positive. Thus, in the segmented layout, well-connected spaces benefit from daylight during brighter months, while in winter these areas may not receive sufficient useful daylight.

Daylight provision (DP) shows a different pattern. In Maly Kack, DP correlates moderately positively with connectivity and visibility in March and June, indicating that spatially integrated areas receive more daylight in the open-plan layout. In contrast, Witomino shows moderate negative correlations between DP and spatial variables. This contrast reinforces the central finding that layout configuration determines how daylight is spatially distributed.

Behavioral correlations further highlight these differences. In the Maly Kack library, connectivity shows a consistent negative correlation with movement intensity and spatial efficacy across all seasons, reaching a strong -0.71 in June. Visibility follows a similar moderate negative trend. This suggests that users in the open-plan library tend to prefer more spatially isolated areas rather than highly integrated ones or that traffic is naturally higher in these secluded sections. No comparable relationship is observed in the Witomino library. In the segmented layout, predefined zones may structure movement independently of spatial integration values, reducing the behavioural influence of connectivity and visibility.

A notable seasonal exception appears in Maly Kack in March, where glare control shows a moderate positive correlation with spatial efficacy. This indicates that improved visual comfort can enhance perceived spatial performance, particularly during transitional seasons. This pattern is not observed in other months or in Witomino.

The relationship between UDI and behavior again differs by layout. In Maly Kack, UDI shows a moderate positive correlation with both movement intensity and spatial efficacy. This suggests that in the open-plan environment, improved daylight conditions directly support user activity and spatial effectiveness. In contrast, Witomino shows negative correlations between UDI and spatial efficacy in March and June, while December presents a moderate positive relationship. Movement data from December also positively correlates with UDI. This indicates that in the segmented layout, additional daylight is beneficial in winter but may reduce comfort or usability during brighter months.

When comparing daylight provision (DP) with behavioral metrics, both libraries show positive correlations with spatial efficacy in December (weak in Maly Kack, moderate in Witomino). This confirms that increased daylight during low-light winter conditions enhances spatial performance in both layouts. However, in Maly Kack during March and June, DP correlates negatively with movement intensity. This suggests that excessive daylight in an open-plan environment may reduce user engagement, possibly due to glare or visual discomfort.

One of important results from the correlation analysis is that spatial layout could fundamentally mediates the relationship between daylight and user behavior. In the open-plan library (Maly Kack), higher spatial integration does not automatically improve visual comfort or behavioral performance; in fact, users often prefer more isolated areas, particularly under high daylight conditions. In contrast, the segmented layout (Witomino) demonstrates more seasonally balanced daylight effects, where increased daylight benefits users in winter but may reduce spatial efficacy in brighter months.

These findings demonstrate that daylighting strategies cannot be evaluated independently of spatial configuration. Layout type, glazing transparency, orientation, and seasonal variation interact to shape both environmental performance and user behavior.

Conclusions

I. Summary of Findings

The dissertation began by situating the study within the broader context of library design and daylighting research, establishing the objectives, rationale, and framework for inquiry. As outlined in Appendix 1, previous research on library buildings was reviewed to determine the most suitable methodological approach. This review highlighted a variety of strategies for exploring the relationship between daylight and user behavior. Behavior mapping, for example, has been widely applied to observe user locations, activities, and seating choices under varying daylight conditions (Dubois et al., 2007; Omar et al., 2018). Daylight simulations using software such as Velux Daylight Visualizer and Rhino assessed how building design and shading influence daylight availability and visual comfort (Okwuosa et al., 2024; Liu et al., 2023; Dabaj et al., 2022). Photography and luminance mapping captured spatial light distribution and its effects on user experience (Aram & Alibaba, 2018; Jørgensen et al., 2012). Questionnaires and surveys complemented observational data, providing insights into user perceptions, seating preferences, and comfort related to daylight (Jørgensen et al., 2012; Izmir Tunahan et al., 2022; Omar et al., 2018). Experiments and user studies further explored how daylight influenced seat selection and movement patterns, both in libraries and similar contexts such as healthcare settings (Izmir Tunahan et al., 2022; Saeidi et al., 2024). Illuminance levels were quantified using light meters to evaluate user satisfaction (Omar et al., 2018; Kilic & Hasirci, 2011), while comparative case studies highlighted the broader implications of design choices for sustainability, openness, and user experience (Edwards, 2011). Collectively, these studies suggest that daylight is not merely an environmental condition but an active factor shaping user behavior, comfort, and spatial engagement, reinforcing the need for methods that integrate subjective, observational, and computational insights.

The literature review revealed consistent patterns in how user movement has been conceptualized in daylighting research. Based on terminology similarities, six distinct categories were identified, with four being particularly relevant to library buildings (Table 3). These categories highlight that daylight influences not only where users sit but also how they navigate and occupy spaces over time. This classification underscores that user behavior in libraries is shaped by both environmental affordances and personal choices, yet a critical gap persists: few studies investigate how users physically interact with daylighting elements, or adaptively relocate in response to glare or discomfort. Understanding this adaptive behavior is central to designing responsive, user-centered library environments.

Table 3. Categories of User Movement in Daylighting Research.

Category	Focus	General Literature References	Library-specific References
User Experience and Spatial Utilization	How daylight supports activities, spatial efficiency, and user experience: integration of comfort, daylight, and movement	Yunus et al. (2010), Hourani & Hammad (2012), Ma & Yang (2022), Ouahrani (2012), Kaiwen et al. (2016), Manurung (2017)	Jørgensen et al. (2012), Edwards (2011), Liu et al. (2023), Mortazaee and Haron (2021)
Occupant's Positions and Choice of Spatial Locations	Occupant positions, seating choices, and trajectories in relation to daylight	Krüger et al. (2019), Zeibo et al. (2021), Park et al. (2015), Parise et al. (2013), Hosseini et al. (2020), Pan & Du (2020), Bian et al. (2018), Huang et al. (2022), Montaser Koohsari Heidari (2022), Atzeri et al. (2016)	Izmir Tunahan et al. (2022), Kilic and Hasirci (2011), Aram and Alibaba (2018), Dabaj et al. (2022)
Walking and Transition	User movement patterns indoors and outdoors; daylight's role in transitions: Pedestrian pathways, transitional experiences, circadian effects.	De Montigny et al. (2012), Zacharias et al. (2001; 2004), Liu et al. (2016), Almaiyah & Elkadi (2012), Tafahomi (2022), Panahiazar & Matkan (2018), Lasagno et al. (2011), Nasybullina et al. (2019), Kristo & Kristo (2021), Andersen et al. (2013)	(Jelić et al. 2016), Nasrollahi and Shokry (2020)
Occupation Over Time	Temporal patterns of occupancy and daylight presence: Occupancy duration and temporal maps.	Hunt (1979), Chiogna & Frattari (2013), Guan & Yan (2016), Moazzeni & Ghiabaklou (2016), Kamaruzzaman et al. (2015), Lolli & Haase (2017), Nezamdoost et al. (2018), Jens & Khoudi (2022)	Omar et al. (2018)

User Interaction with Daylighting Elements	Users' physical interactions with daylighting elements and the disruptive effects.	Konis, 2013; Katsanou et al., 2019; Hammes & Weninger, 2023; Wang & Boubekri, 2011; Zhang & Barrett, 2012; Van Den Wymelenberg, 2012; Amorim et al., 2022; Lim et al., 2017; Rakha et al., 2018; Gunay et al., 2017; Bournas & Dubois, 2020; Aghemo et al., 2014; Perwita Sari & Chiou, 2018; Rezaee et al., 2009; Sakarellou-Tousi & Lau, 2009	No research in the context of libraries.

Within the context of library buildings, research has instead focused on movement through categories such as spatial utilization, user positions, walking patterns, and occupation over time, with studies highlighting the importance of daylight in shaping experiences, seating choices, and energy efficiency. These findings underscore the role of daylight in creating responsive, user-centered, and sustainable environments, though a deeper understanding of user movement also requires consideration of different library types - public, special, school, and academic (Kim & Choi, 2012; Illuminating Engineering Society, 2020).

Chapter 1 not only reviewed contemporary library buildings but also examined typologies and case study selection criteria, providing a foundation for understanding how daylight and user movement intersect in practice. The choice of Maly Kack and Witomino illustrates how contrasting spatial strategies, that is open-plan versus closed-plan layouts, could affect daylight distribution, connectivity, and movement, offering a natural experiment for understanding behavioral patterns.

The conceptual framework introduced in Chapter 1 further situates this study within broader trends in contemporary library design. Lushington et al. (2019) identified twelve historical periods influencing library design, six of which directly affected daylighting and movement, notably the 2004 shift toward the 'Pluralism of the Roles and Identity of the Library,' exemplified by Rem Koolhaas's Seattle Central Library (Roth, 2010, 2015). Emerging trends highlighted by Lechman (2024), including flexible spaces, public pavilions, spiral circulation, and libraries as catalysts for urban life, emphasize the evolving role of libraries as both functional and social environments. User-centered factors such as comfort, collaboration, socialization, flexibility, and connectivity (Abowardah et al., 2019, Table 1.1), further reinforce that physical and emotional attachment to library spaces is shaped by how daylight and movement support user needs. Peterson (2023) stresses that library atmospheres emerge from sensory and social experiences, categorized as concentration, communication, relaxation, and exploration (Table 1.2). Together, these insights suggest that designing for daylight and movement requires attention to both spatial configuration and human behavior, validating the selection of Mały Kack and Witomino as contrasting but complementary case studies for examining adaptive and experiential responses.

The selection of case studies was guided by the review of contemporary library trends and regional developments. Libraries had to be public, constructed after 2004, originally designed as standalone library buildings, and reflect modern spatial qualities such as daylighting, flexible layouts, and user-centered design. Applying these criteria to the Tri-City area (Gdansk, Gdynia, and Sopot), only two Gdynia branches - Witamino and Maly Kack - met all requirements, serving as modern cultural landmarks with well-designed interiors, strong community connections, and spaces that support contemporary library functions and user engagement. Both libraries are adjacent to community centers and occupy neighborhoods with the same names. Each library is designed on two floors with similar occupied space. Mały Kack features an open-plan layout with curved walls; daylighting on the ground floor is provided through large windows, while the second floor is primarily illuminated by a skylight positioned above a spiral staircase, visually and physically connecting both floors. In contrast, Witomino has a segmented layout, with rooms designated for specific functions and reading areas mostly on the first floor. The floors are connected by a more concealed staircase and an elevator. Its angular walls and large windows provide daylighting, but the library lacks a skylight.

While rooted in established literature, this approach is novel in several ways, particularly in the design of the questionnaires and observation sheets, which were tailored to capture detailed user perceptions, seating preferences, movement patterns, and duration of stay in library settings. Another innovative aspect lies in the way data from multiple sources - questionnaires, observations, building plans, and simulations - were systematically gathered, integrated, and transformed for analysis. The methodology combined subjective, objective, and mixed-methods data, including user perceptions, observation-based behavior, space syntax analysis from AutoCAD plans simplified in DepthmapX, and 3D daylight simulations in Rhino using the Grasshopper plugin AnnuOWL. This integrated, multi-layered approach allowed a comprehensive assessment of how daylighting conditions influence user movement patterns in libraries.

A recent study by Pan et al. (2025) employed multi-layered data collection, including space syntax and daylighting simulations, to investigate the relationship between spatial design, environmental factors, and user behavior. While both studies share a focus on these interactions, they differ in context, methodology, and data emphasis. Pan et al. examined hybrid office environments, predicting seat occupancy using spatial metrics, thermal and visual comfort, and user preferences, relying on sensor-detected occupancy, environmental measurements, simulations, and statistical models over a year.

Overall, while Pan et al. highlight the predictive effects of environmental and spatial metrics on occupancy, this study provides a user-centered, context-specific framework for libraries, emphasizing the interplay of daylighting and movement and extending insights beyond purely quantitative occupancy models.

This research has explored the intricate relationship between daylighting strategies and user movement within library architecture, advancing knowledge through a multi-layered and mixed-methods investigation. Beginning with a systematic review, six categories of user movement in daylighting research were identified, of which four were found to be relevant to library contexts. The review revealed a clear gap in existing literature: while user experience, spatial utilization, seating choices, and temporal occupancy have been examined in libraries, little attention has been given to users' direct physical interactions with daylighting elements, such as adaptive behaviors, dissatisfaction, or relocation in response to glare and visual discomfort. Addressing this gap required extending insights from broader environmental behavior studies into the specific context of libraries. Based on carefully defined criteria, two libraries in Gdynia - Mały Kack (open-plan) and Witomino (closed-plan) - were selected as case studies, providing contrasting yet comparable contexts for empirical exploration.

This research developed and applied a novel methodological framework combining subjective, objective, and mixed-methods approaches. This included behavior mapping, tailored questionnaires, observation sheets, space syntax analysis, and 3D daylight simulations, integrated within a coherent workflow. The novelty of this approach lies in its extensive use of user-centered data alongside computational and spatial analysis, enabling a more nuanced understanding of how daylight interacts with movement and experience in libraries. Unlike comparable studies in office environments, which focus on predictive modeling of occupancy, this research emphasized lived experience and behavioral response, reflecting the unique functions and cultural role of libraries.

The findings offer several insights with theoretical and practical implications. Questionnaire-based statistical analysis revealed that daylight preference does not directly extend time spent in a location but interacts with comfort, privacy, and environmental factors. Personality type significantly influenced attitudes toward daylight, with extraverts valuing it more than introverts, underscoring the need for differentiated spaces that balance bright, open areas with quieter, enclosed alternatives. Behavioral types also shaped preferences, as users engaged in task-focused searching favored less direct sunlight, highlighting the importance of zoning libraries with both naturally lit contemplative areas and evenly illuminated browsing zones.

Spearman correlation analyses further demonstrated that the effects of daylight are layout-dependent. In the open-plan Mały Kack library, connectivity and visibility often correlated negatively with movement intensity, as users gravitated toward more isolated, comfortable areas. Seasonal dynamics were also evident, with glare and UDI exerting varying effects across the year. In contrast, the segmented Witomino library exhibited weaker correlations, suggesting that compartmentalized layouts may moderate the influence of daylight on movement patterns. Together, these findings underscore the complex interplay between spatial configuration, daylighting, and user movement.

Overall, this dissertation contributes in three main ways. First, it identifies and addresses a gap in library daylighting research by focusing on user movement and adaptive behavior rather than only spatial utilization. Second, it develops and demonstrates a novel mixed-methods approach that integrates subjective perceptions with computational and observational data, offering a framework for future research. Third, it generates new empirical insights into how daylighting strategies, spatial configuration, and user characteristics shape movement and space use in libraries, with implications for both design and operation.

Future research could extend this work by testing a broader range of library types (public, school, academic, special) across diverse cultural contexts, incorporating long-term sensor-based monitoring, and examining interactions between daylight and other environmental factors such as acoustics or thermal comfort. At a practical level, the findings encourage architects and designers to embrace flexibility, providing a spectrum of spaces that accommodate varied daylight preferences, seasonal changes, and user behaviors. By doing so, libraries can be designed not only as repositories of knowledge but also as responsive, user-centered environments that enhance well-being, learning, and community life.

II. Final Conclusions and Research Implications

The main objective of this research was to analyze the relationships between daylight conditions and user behavior and movement in contemporary library interiors, considering spatial atmospheres, architectural layout, seasonal variation, and user characteristics. Overall, the findings demonstrated that **daylight operates as one component within a broader behavioral system** rather than as an isolated design driver. Its impact is mediated by **spatial configuration**, **user characteristics**, and **task-related needs**. Therefore, the findings indicate that user needs should be prioritized when evaluating daylight performance in contemporary library interiors, particularly in relation to the spatial atmospheres that shape user experience.

As defined in this doctoral study, **spatial atmospheres** - such as concentration, communication, relaxation, and exploration - emerge from the interaction between architectural elements and user behavior, and they mediate how daylight conditions are perceived and used within space. This is reflected in approaches that integrate daylight not only as a technical environmental factor, but also as a condition influencing privacy, circulation patterns, behavioral diversity, and the quality of different atmospheric zones within the library. At the same time, architectural form can still be shaped in relation to natural light - for example, through the creation of shared atrium spaces that support communicative or exploratory atmospheres, or more enclosed and controlled areas that enhance concentration and relaxation, as well as through spatial arrangements that emphasize visual connections to the outside.

Designing for adaptability, across seasons, and activity patterns, emerges as more critical than achieving high daylight levels alone. This is particularly important in the context of Gdynia's climate, which is temperate and characterized by significant seasonal variations in daylight. Libraries serve as public spaces where people spend time, especially during the winter period, and differences in use in relation to daylight conditions highlight the city's unique climatic context. In this regard, designing for adaptability - across seasons and varying activity patterns - emerges as more critical than simply achieving high levels of daylight.

The above results of this doctoral research have fulfilled the **first part of the main objective**.

Additionally, as the second part of the main objective the study aimed to develop and apply a **mixed-method framework** combining parametric simulations and observational data to examine interactions between spatial configuration, environmental quality, and human experience. This was achieved through an innovative framework integrating daylighting simulation, space syntax computations, and observational data, both visual and correlational forms. Within this framework, **Movement Intensity (MI)** and **Spatial Efficacy (SE)** were introduced as research-defined observational indicators. MI represents the frequency of user relocations to specific spatial points within the library, derived from behavioral mapping and recorded observations. SE represents a composite measure of spatial performance, based on observed occupancy and duration patterns, reflecting the effectiveness of spatial locations in supporting sustained use. By overlapping **observation-based diagrams** (Spatial Efficacy and Movement Intensity) with **space syntax and daylight simulation maps**, insights were drawn and relationships were examined. Furthermore, by assigning each point in space specific scores reflecting daylighting conditions (UDI Compliance, Glare Control, and Daylight Provision), space syntax values (Connectivity and Visibility), Spatial Efficacy and Movement Intensity, rank-based correlations could be established.

In this doctoral thesis, a number of specific objectives were defined, which are addressed in the study.

The conceptual objective of this study was to identify how **user behavior, particularly movement**, is addressed in daylighting research studies. The results of the systematic review showed that user activity is commonly addressed through four distinct but interrelated dimensions. Spatial utilization refers to how different areas of a space are occupied and distributed by users. Place preferences describe the selection of specific spatial locations based on environmental and experiential factors such as daylight, comfort, and privacy. Movement trajectories and transitions capture the paths, flows, and directional changes of users as they navigate through space. Temporal patterns of space use refer to how occupancy and movement behaviors evolve over time, including variations across different periods of the day or use cycles.

Among those specific objectives, three empirical objectives were defined, focusing on: identifying how spatial layout characteristics (open-plan versus closed-plan configurations) mediate this relationship; exploring how different types of library users influence preferences for daylight and spatial conditions; and investigating the relative importance of non-lighting factors (such as privacy, comfort, and noise) in comparison to daylight in seating selection and duration of stay.

The first empirical objective was to examine differences in how daylight influences user preferences and spatial behavior in **open-plan and closed-plan library layouts**. The results obtained through the questionnaires (refer to the Tables 2.5, and 2.6 in Chapter 2) showed that both libraries show similar patterns

- lighting shapes all atmospheres, comfort supports calm and focused spaces, and movement/accessibility define social and stimulating areas - but the open-plan Maly Kack Library places stronger emphasis on privacy, accessibility, and practical usability than the closed-plan Witomino Library. Moreover, based on the combined responses to questions 1, 2, and 10, in both libraries respondents selected one of four seating atmospheres - calm, quiet focused study, open/social conversation, and stimulating environment - and indicated their purpose and perceived spatial qualities of the chosen place. Social interaction spaces were mainly associated with daylight and social interaction, while the other atmospheres were primarily influenced by lighting (often electrical) and comfort-related factors. It is noteworthy that open-plan users selecting calm spaces for taking a break additionally emphasized privacy and noise reduction.

The second empirical objective was the to explore the relationship of **user behavior type** and naturally lit spaces. A U-test on the user questionnaire data was run to test whether library user behavior type influences preference for naturally lit spaces. Using questionnaire data (behavior type vs. lighting preference) and Mann-Whitney U-test, results showed that only the **'Seeding by search' behavior type significantly preferred less direct sunlight**, favoring diffused or artificial lighting. In other words, only the 'Seeding by search' behavior type showed a significant preference against direct sunlight, favoring diffused or artificial lighting. while not investigated as an objective, it is also worth mentioning that, according to the responses from the user questionnaires, **personality type influences the preference for daylight in the library**. Using questionnaire data (personality type vs. importance of daylight) and ANOVA with pairwise comparisons, results showed a statistically significant difference between introverts and extraverts ($p = 0.032$), with extraverts placing greater importance on daylight. In other words, extraverts placed significantly greater importance on daylight compared to introverts, while individuals in-between showed no significant difference. In addition, **preference for daylight in seat selection influences sensitivity to observing other users' movement.** Using questionnaire data (reason for seat selection vs. importance of noticing others' movement) and Mann-Whitney U-test, no statistically significant difference was found, though a slight trend indicated daylight-preferring users were more attentive to others' movement, suggesting potential implications for designing transparency and open spaces in libraries. Finally, **users more influenced by observing others' movement value daylight and view-out more than those less influenced.** Using questionnaire data (impact of observing others vs. importance of daylight/view) and Mann-Whitney U-test, no statistically significant difference was found ($H = 2.97$, $p = 0.158$), though descriptive trends suggest a potential link between attentiveness to social dynamics and preference for daylight and views. In other words, while no statistically significant difference was found, descriptive trends suggest users more attentive to others' movement may prefer daylight-rich spaces with views.

The last empirical objective of the research was to identify **non-lighting factors** (e.g. comfort, privacy, quietness) that may outweigh daylight in seat selection and movement. This was tested through the questionnaire analysis by examining whether users' preference for daylight in seat selection affects time spent at that location. Using questionnaire data (seat selection reason vs. time spent) and a Mann–Whitney U-test, the analysis found no statistically significant difference; however, a trend suggested that users choosing seats for reasons other than daylight stayed longer, highlighting potential design considerations for comfort, privacy, and other environmental factors. In addition, according to the results from the user questionnaire, although no statistically significant difference was found, users who selected seats for reasons other than daylight tended to stay slightly longer.

According to the results above, the **hypothesis that non-lighting factors such as comfort, privacy, and quietness have a greater influence on seat selection than daylight alone is partially supported.** While no statistically significant difference was found, observed trends indicate that users selecting seats based on non-lighting factors tend to remain longer, suggesting their greater practical importance in spaces intended for focused work.

Among the specific objectives, three comparative objectives were defined, focusing on: comparing how daylight conditions - particularly Useful Daylight Illuminance (UDI), glare, and daylight provision - influence user behavior and spatial experience in open-plan and closed-plan library layouts; investigating how seasonal variation affects the relationship between daylight conditions, spatial configuration, and user behavior; and analyzing how different spatial configurations modify daylight distribution patterns and their behavioral outcomes, including movement intensity and spatial efficiency.

The first objective was to compare the impact of daylight on spatial behavior in **open-plan versus closed-plan library layouts**. Based on the results derived from the Spearman correlation analysis of the different variables in the study, three results were seen. First, **connectivity and visibility** were moderately positively correlated, with stronger relationships in open-plan layouts due to fewer physical barriers. This finding suggests that highly connected and visually open spaces naturally enhance spatial legibility. However, this could come with a risk of reduced comfort when users prefer isolation. Second, in open-plan library, **connectivity and visibility negatively correlated with movement intensity and**

spatial efficacy, whereas in closed-plan no significant correlations are observed. This could show that highly connected spaces do not necessarily encourage movement in open-plan layouts. Instead, users gravitated toward isolated zones. This highlights the need to design open libraries with varied levels of exposure and retreat, ensuring circulation pathways remain efficient but do not dominate the most attractive daylight areas. Third, **daylight provision correlates positively with spatial integration** open-plan library but negatively in closed-plan, showing layout-dependent daylight distribution patterns. This finding could illustrate how layout fundamentally conditions daylight distribution. In open-plan spaces, integration enhances daylight penetration, while in segmented spaces, too much integration can reduce spatial performance in brighter seasons. **UDI positively influences movement and spatial efficacy** in the open-plan library, but in the closed-plan library, higher daylight can reduce spatial performance in brighter seasons. This could illustrate layout-dependency.

The other comparative objective was to investigate seasonal variation in daylight conditions and their effects on user movement, and spatial efficacy. Based on the results derived from the Spearman correlation analysis of the different variables in the study, four findings became apparent. First, in open-plan library, **visibility correlates positively with UDI in December** but negatively in March and July, reflecting seasonal shifts in daylight-spatial interactions. This could underscore the importance of seasonal daylight management. In winter, openness improves daylight sufficiency, but in brighter seasons, it may lead to overexposure. Seasonal-responsive shading systems, combined with spatial zoning that adapts to time of year, could mitigate these seasonal challenges. Second, **in winter, both libraries show positive correlations between daylight provision and spatial efficacy**, but in the open-plan library, higher daylight in spring and summer can reduce movement most likely due to glare. This could underscore the importance of seasonal adaptability. While daylight is universally beneficial in darker months, glare and overheating risks in summer require more active management in open-plan spaces. Third, in closed-plan, **UDI correlates negatively with spatial properties (Visibility and Connectivity) in December** but positively in later months, highlighting how spatial configuration affects seasonal daylight dynamics. This could be showing that segmented layouts respond differently to daylight across the year. This suggests that distributed windows in separate rooms can provide resilience against overexposure in summer while still requiring thoughtful placement of high-use areas in winter to ensure sufficient daylight. Fourth, **improved glare control in open-plan library during March is associated with higher spatial efficacy**, indicating that visual comfort enhances space usage seasonally. This could highlight how comfort directly drives space usage. Seasonal glare control strategies can therefore enhance not only visual comfort but also the functional use of open-plan libraries.

The last comparative objective was to investigate the relationship of daylight conditions with the spatial layout characteristics. Based on the results derived from the Spearman correlation analysis of the different variables in the study, three outcomes were observed. First, **in the open-plan library, better glare control occurs in less connected and visually integrated areas**, with seasonal differences amplifying glare in peripheral zones. Seasonal variation amplified this effect, indicating the need for adjustable shading or seasonal strategies in exposed zones. Second, **in the closed-plan library, a segmented layout shows slightly positive correlations between spatial properties and glare control**, suggesting unidirectional daylight access moderates glare. This could imply that segmentation can act as a passive strategy to achieve more stable daylight comfort without heavy reliance on additional glare-control technologies. Third, **users in the open-plan library tend to prefer isolated areas**, explaining lower movement and spatial efficacy in highly connected zones, unlike in the segmented layout. This could show that how segmented layouts inherently manage spatial performance more evenly.

According to the abovementioned results, the **hypothesis that daylight conditions influence user movement patterns and spatial occupancy differently in open-plan and closed-plan layouts is supported.** However, the results indicate that this influence is not direct, but mediated by spatial configuration, particularly connectivity and visibility, and varies depending on seasonal conditions.

Taken together, the findings demonstrate that daylight does not directly determine user behavior and movement in library interiors, but operates as a mediated component within a broader behavioral system, in which its influence on spatial efficacy and movement Intensity is conditioned by spatial configuration (connectivity and visibility), seasonal variation, and user behavioral characteristics, thereby shifting the role of daylight from a parameter to be maximized toward one that must be strategically distributed in relation to privacy, comfort, and circulation logic to support diverse spatial atmospheres and patterns of use.

Overall, the findings of the study provide strong support and contribute to a positive confirmation of the main thesis that:

“Daylighting is one of the most important factors defining the architectural form of the library as a building, however, spatial and functional configuration of contemporary libraries plays a key role in how the space is used in relation to daylight. Moreover, seasonal variation significantly modifies the relationship between daylight conditions and user behavior."

III. Limitations of the Research and Future Studies

As a limitation, it should be noted at the outset that, although the selection of libraries for this study was conducted in a systematic manner, the sample remains limited. The research is based on only two buildings, and therefore cannot be considered fully representative. It is acknowledged that the study should be extended to include a larger number of libraries of varying sizes, such as regional and university libraries. Additionally, the findings may be influenced by local context, which suggests the need for broader investigation across different settings.

It is also important to note that the study did not examine electric lighting conditions, nor did it include user perceptions related specifically to lighting quality. Additionally, it is acknowledged that the tools used in this study are not the only ones available, and that similar research could be conducted using other digital methods. However, the selection of these tools was largely determined by their accessibility. It should also be emphasized that they are well-established, validated, and widely referenced in the literature, and have been used by researchers in countries such as the UK and Belgium.

Another limitation of the study is the relatively small questionnaire sample (approximately 140 responses), which restricts the depth of statistical analysis. Additionally, the findings may be influenced by local context, which suggests the need for broader investigation across different settings. Future research could expand the sample size to enable more detailed subgroup and inferential analyses.

This study adopts a mixed-method approach combining daylight simulation, Space Syntax Analysis (SSA), Visibility Graph Analysis (VGA), behavioral mapping, and survey data, enabling a comprehensive examination of the relationship between spatial configuration, environmental conditions, and user behavior. The use of direct on-site observations in a non-digital format increases ecological validity by capturing real user behavior in natural conditions. The study also incorporates seasonal variation through week-long observations across three seasons, allowing for temporal comparison of user behavior and environmental performance. Furthermore, the daylight simulation tool AnnuOWL demonstrates a strong alignment with the methodological framework adopted in this research, supporting the validity of the chosen analytical approach. In addition, the integration of multimodal datasets and a cross-case analysis of two library buildings enhances the robustness and comparative value of the findings.

In addition, the observational periods, limited to one week per season, provide only temporal snapshots and may not fully capture longer-term behavioral patterns. Future studies could adopt extended or continuous monitoring to improve temporal resolution. Furthermore, gaps between observation periods and the lack of continuous tracking also limit the ability to capture dynamic changes in user behavior. This could be addressed in future research through sensor-based or automated data collection methods.

Moreover, the presence of an observer during on-site data collection may have influenced user behavior to some extent. Future studies could reduce this bias by using less intrusive or automated observation methods. Finally, one of the other limitations of the study is the simplification of continuous variables into ordinal categories, which may reduce the sensitivity of the analysis. However, this approach enabled the integration of heterogeneous datasets. Future research could retain continuous measures to allow for more precise statistical modelling.

It is also important to note that this methodological approach could be applied to other building typologies to enhance its reliability and generalizability. In addition, the use of automated coding or scripting methods could improve the efficiency and precision of data extraction from analytical tools. Finally, to strengthen the findings related to open-plan and closed-plan library layouts, future research should include a broader sample of library cases to enable more robust comparative analysis. Additionally, the observational technique could also be expanded to capture a wider range of behavioral data beyond trajectories, counts and duration, such as seating orientation, which may provide deeper insight into user interaction with space. This could potentially be achieved through more advanced tools beyond direct observation, such as sensor-based tracking or video-assisted analysis. Finally, to strengthen the findings related to open-plan and closed-plan library layouts, future research should include a broader sample of library cases to enable more robust comparative analysis.

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Appendices

APPENDIX 1 – Review of the Methodology

Review of Methodological Foundations

This appendix reviews the research methods that informed the development of the methodology for this study. It highlights approaches such as Methods of Movement Assessment in Daylighting Studies, Methods of Daylighting Assessment in Buildings, and Space Syntax: A Method of Movement Pattern Analysis. It also discusses Data Types and Collection Methods, including Methodological Validation through Comparative Analysis of Previous Studies, explaining how these approaches were combined to form the study's research design.

1. Methods of Movement Assessment in Daylighting Studies

To provide an overview of the methodological contributions from studies on daylighting that have considered, measured, or analyzed user movement, a review was conducted. Table below (Table 2) depicts the methods used to analyze movement primarily in the daylighting studies.

Table 2. Methods of evaluation of movement in the built space based on the scale and time of the movement for micro, mid, macro, and mega scales.

Movement level / **Timescale**	**Micro-scale: Imbedded motion / movement of organs**	**Mid-scale: Reposition / redirection / ocular movement / movement of the joints**	**Macro-scale: Relocation / movement pattern**	**Mega-scale: Occupation cycle / migration / walking rate / trajectory**
Instant (**a range of seconds)**	• Biometric analysis (EEG, SGR, EMG, PPG) (Ergan et al. 2019) • Affectiva iMotions video analysis (Kulke et al. 2020) *	• Eye Tracking, Motion sensing (Yamín et al. 2016) • Adaptive zone (Bian et al. 2018) • Time-of-Flight sensing (Jia et al. 2014) • Vision-based pose estimation (Liu et al. 2016)	• Video recording analysis (Kulke et al. 2020) • Direct Observation (Peper et al. 2017) • Time-of-Flight sensing	• Long Short-Term Memory (LSTM) trajectory prediction (Zeibo et al. 2021)

		• Motion sensing (Park et al. 2015)		
Momentary **(minutely or a range of minutes)**	• Biometric analysis (EEG, SGR, EMG, PPG) • Affectiva iMotions video analysis	• Eye Tracking • Adaptive zone • Time-of-Flight sensing • Vision-based pose estimation • Motion sensing	• Timelapse footage with short intervals (Hunt 1979) • Video recording analysis • Space syntax (Saeidi et al. 2024) • Direct Observation (Kyle Konis 2013) • Time-of-Flight sensing • Vision-based motion tracking (Liu et al. 2016) • Behavioral mapping (Kyle Konis 2013) • Monitoring (Cılasun Kunduracı & Kazanasmaz 2019) (Lasagno et al. 2019)	• Datalogging (Hammes & Weninger 2023) • Monitoring (Omar et al. 2018) • Long Short-Term Memory (LSTM) trajectory prediction • Space syntax • Behavioral mapping
Temporary **(hourly or a range of hours)**	• Smart bracelet recording (Chomistek et al. 2017) *	• Eye Tracking • Adaptive zone • Time-of-Flight sensing	• Timelapse footage with intervals • Space syntax • Direct Observation (Zacharias et al. 2001) • Time-of-Flight sensing • Vision-based motion tracking • Behavioral mapping (Izmir Tunahan et al. 2022) (Dubois et al. 2009) • Monitoring	• Datalogging • Monitoring (Nezamdoost et al. 2018) • Space syntax • Behavioral mapping
Diurnal **(daily)**	• Smart bracelet recording	• Actigraphy (Lee & Boubekri 2020)	• Timelapse footage with long intervals (Krüger et al. 2019) • Observation (Guo et al. 2022) • Actigraphy • Space syntax • Time-of-Flight sensing	• Datalogging • Monitoring • Space syntax
Periodic			• Actigraphy	• Actigraphy • Monitoring

(weekly)	-	-		• Web-based observation (de Montigny et al. 2012)
Cyclical **(monthly)**	-	-	• Actigraphy	• Actigraphy • Monitoring • Web-based observation
Quarterly **(seasonally) / Annual** **(yearly)**	-	-	-	• Monitoring (Aghemo et al. 2014) • Observation • Web-based observation

* Method came from beyond the scope of daylighting-specific studies

In this study, direct observation, behavioral mapping, and space syntax analysis techniques were employed (Fig. 9). These methods were selected based on the scope of the study, availability of resources, and alignment with established approaches in the literature. Given the study's focus on movement patterns across varying temporal and spatial scales, these methods provided a balanced integration of qualitative and quantitative data. Direct observation and behavioral mapping allowed for micro and mid-scale insights into user behavior, while space syntax offered macro- and mega-scale spatial analysis.

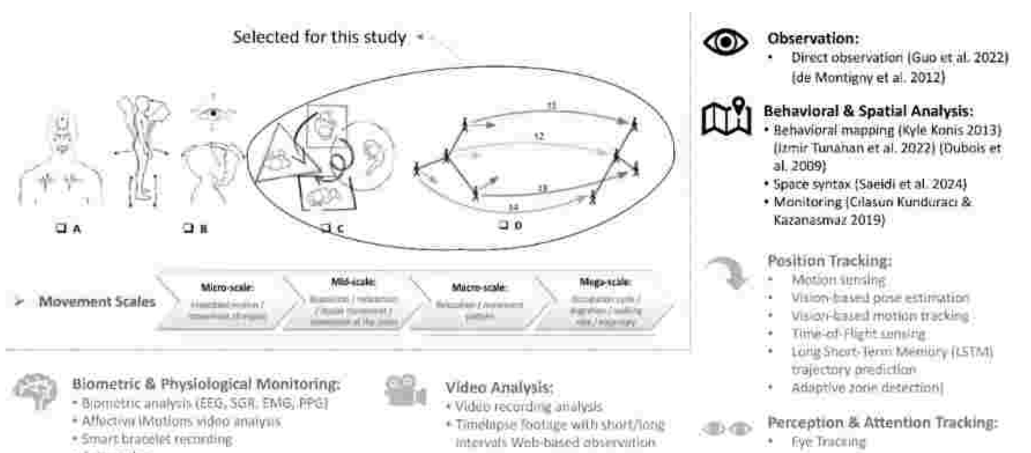

Figure 9. Methods reviewed (in grey and black color) and selected (in black color) for the evaluation and assessment of movement in this study (Source: author).

2. Methods of Daylighting Assessment in Buildings

The assessment and evaluation of daylight in buildings are fundamental to sustainable architectural design, significantly influencing energy efficiency, occupant comfort, and overall well-being. This evaluation typically integrates both qualitative and quantitative approaches to analyze the quantity, distribution, and quality of natural light within indoor spaces. Based on the reviewed literature, key methods include daylight measurements and metric calculations (Pan & Du, 2022; Atzeri et al., 2016; Koohsari & Heidari, 2022; Arango-Díaz et al., 2022; Taştemir et al., 2020; Adam et al., 2016; Zhou et al., 2015), simulation techniques (Huang et al., 2022; Sepulveda-Gil et al., 2022; Kamaruzzaman et al., 2015; Chaudhary & Jain, 2014; Ámundadóttir et al., 2013; Villalba et al., 2018; Moazzeni & Ghiabaklou, 2016; Andersen, 2015), and subjective assessments through surveys and interviews (Hourani & Hammad, 2012; Izmir Tunahan et al., 2022; Rockcastle et al., 2017; Jiang et al., 2022; Ouahrani, 2012; Panahiazar & Matkan, 2018; Bournas & Dubois, 2020). While simulation tools are widely adopted in daylighting research and design due to their predictive capabilities, in-situ measurements are essential for capturing real-time and context-specific lighting nuances. These are often complemented by subjective evaluations to better understand occupants' perceptions of daylight quality and comfort. Among simulation tools, Radiance-based software is particularly dominant, often employed through plug-ins integrated with Rhinoceros. Climate based simulation (CBDM) is currently one of the most approved methods to analyze daylighting condition in buildings.

A notable recent advancement in this area is the AnnuOWL plug-in for Grasshopper, offering enhanced capabilities for annual and even monthly daylight performance analysis (Maskarenj et al., 2022) (Maskarenj et al., 2023). This software uses three entry data to simulate daylighting through grid-based analysis of (such as UDI, sDA, and DF simulations) and Occupant Visual and Non-Visual Illumination (OVNI) diagrams (Fig. 10) (Maskarenj, n.d.).

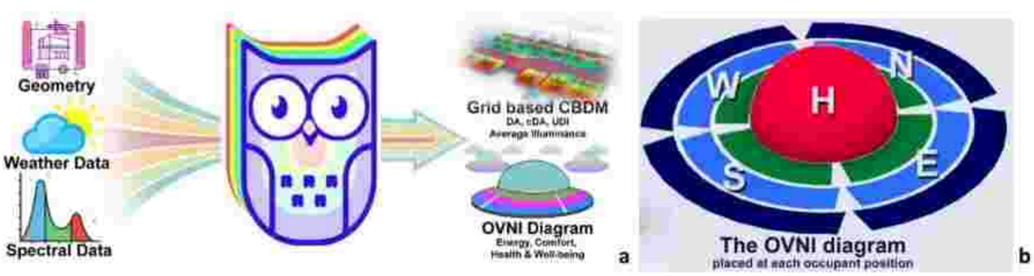

Figure 10. AnnuOWL software workflow. Data input and output (a), OVNI diagram (b) (Source: https://marshalmaskarenj.github.io/).

OVNI diagram will be generated based on the desired locations that the user wants to create simulation for. Each OVNI consists of a central hemisphere and three surrounding rings, each divided into four segments oriented toward North, East, South, and West. The hemisphere represents sufficient horizontal illuminance at table height, evaluated using Radiance grid-based simulations during occupied hours. The rings reflect vertical viewing conditions at eye level:

the inner ring indicates circadian potential as a proxy for occupant health and well-being; the middle ring assesses protection from discomfort glare, representing visual comfort; and the outer ring, still under development, will evaluate view quality and occupant satisfaction.

Daylight sufficiency is assessed by categorizing gridpoint illuminance levels into three distinct ranges: Minimum (300–500 lux), Medium (500–750 lux), and High (above 750 lux). For each occupied hour at every gridpoint, a binary value is assigned—1 if the illuminance falls within the specified range for a given category, and 0 otherwise. These values are then aggregated across all occupied hours and divided by the total number of occupied hours to compute a normalized score for each category. If the score for a given level exceeds 50%, the gridpoint is awarded 1 point for that category. Using daylight simulation tools such as Radiance, horizontal plane illuminance values are calculated across all gridpoints and occupied hours. Each gridpoint's overall daylight sufficiency is then determined based on the highest category in which it scores a point, classifying it as High, Medium, Minimum, or Non-Compliant.

Glare analysis, on the other hand, evaluates visual comfort at designated viewpoints through the Daylight Glare Probability (DGP) metric, derived from vertical plane illuminance data in four orientations. Similar to the sufficiency method, each occupied hour is categorized into one of three comfort levels: High (DGP < 0.43), Medium (0.43–0.45), and Minimum (0.45–0.47). A value of 1 is assigned if the DGP falls within the defined range for the respective category; otherwise, 0 is assigned. These hourly values are summed and normalized by the total number of occupied hours to yield a score per category for each viewpoint. If a score exceeds 95%, the viewpoint earns 1 point for that category. The highest level at which a viewpoint receives a point determines its glare performance classification: High, Medium, Minimum, or Non-Compliant.

3. Space Syntax: A Method of Movement Pattern Analysis

Space Syntax is a powerful analytical framework for understanding how architectural and urban spaces shape human perception and behavior. It originates from Hillier & Hanson (1984), who introduced a graph-based representation of space—breaking environments into nodes (convex spaces or axial lines) linked by accessibility or visibility to predict social and movement patterns of space. Therefore, this method offers a strong objective analysis on the human movement inside buildings.

Hillier and Hanson (1984) conceptualized architectural space as a network of discrete units—linked not just physically, but through configurational relationships measurable via graph theory. Among the earliest and most fundamental parameters introduced was connectivity, defined as the number of directly linked spaces from any given location (Hillier and Hanson, 1984, P.103) (Hillier, 1996, P.94). This metric provides insights into local accessibility and is strongly correlated with patterns of human movement, particularly in interior architectural layouts. Building on this foundation, Hillier (1996, p. 94) introduced depth, choice, and integration as key spatial measures: depth quantifies the distance or number of steps between spaces in a system, choice measures how often a space lies on the shortest paths connecting all other spaces (indicating potential for through-movement), and integration assesses how easily a space can be reached from all others, reflecting its overall accessibility and destination attractiveness. Another term is Entropy in a way that higher entropy values indicate more diverse movement options within a spatial system, whereas lower entropy values reflect more predictable and uniform movement patterns (Hillier & Hanson, 1984, p. 108). Similarly, higher mean depth values signify spatial isolation, requiring more steps to access other spaces, while lower mean depth values indicate centrality and greater integration within the system (Hillier & Hanson, 1984, pp. 364–365).

However, traditional axial analysis had limitations in representing complex and curved geometries. Addressing this, Turner et al. (2001) proposed Visibility Graph Analysis (VGA), which operationalizes spatial perception by analyzing inter-visibility between points on a grid. VGA introduced new metrics such as visual connectivity and visual integration, allowing researchers to examine how visibility, rather than purely topological connections, shapes human spatial behavior. This shift acknowledged the central role of perception-driven navigation, where people tend to move toward visible paths and destinations. Tools like DepthmapX (Space Syntax Online, 2025) have since implemented these parameters, making it possible to simulate and evaluate spatial environments based on their capacity to support orientation, movement, and social interaction.

In building scale, connectivity and visibility together could give the full picture of movement patterns by avoiding the repetition of the other parameters (e.g. integrity, choice, and depth). These two parameters are behaviorally grounded measures for analyzing spatial movement.

4. Data Types and Collection Methods

Diagram below shows the flowchart of the process of data collection and analysis including the selected methods for this research (Fig. 11).

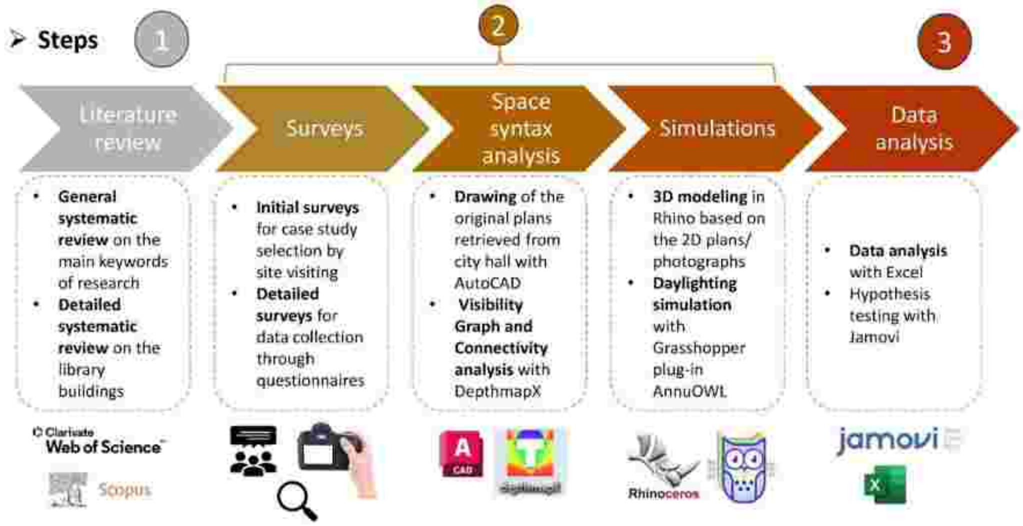

Figure 11. Flowchart of the research methodology (Source: Author).

In this research, the aim is to investigate the correlation between two key parameters: daylighting within a library space and the movement patterns of library users. The study seeks to understand how the availability and quality of daylight influence how people navigate and interact with the library environment. To explore this relationship, a combination of diverse research techniques is employed, reflecting a multi-dimensional approach to data collection and analysis.

The research adopts a mixed-methods approach, integrating both quantitative and qualitative tools to provide a comprehensive understanding of the problem. On the quantitative side, techniques such as Rhino 2D and 3D modeling, DepthmapsX Space Syntax, daylight simulations through ClimateStudio, and daylight measurements are utilized to model and measure the physical aspects of the library space. These methods help in creating spatial configurations and daylight conditions that can be quantified and analyzed. For instance, space syntax is used to generate metrics that reflect spatial connectivity and movement potential, while daylight simulations provide precise data on the distribution and intensity of natural light in different areas of the library. False color imagery further contributes by offering a visual representation of light levels, assisting in the interpretation of lighting conditions across the space.

Complementing these computational techniques, the research incorporates qualitative methods such as observations and questionnaires to capture user behavior and perceptions within the library. Through direct observation, the study tracks how library users move in response to lighting conditions, identifying patterns in their movements that may be influenced by daylight availability. The use of questionnaires allows for the collection of subjective data from both users and librarians, providing insights into how they perceive the influence of daylight on their experience and behavior within the library.

This methodological approach in this research is rooted in the pragmatist research paradigm (Groat & Wang, 2013, p. 89), which values practical and flexible solutions tailored to the research question. Pragmatism allows for the integration of diverse techniques—quantitative modeling, simulation, and qualitative observation—depending on what is most effective for exploring the relationship between daylighting and user movement. By utilizing tools that gather both numeric and contextual data, the study strives to find actionable correlations between the physical environment and user behavior, thus providing a grounded, real-world understanding of the impact of daylighting on library use.

Overall, this inquiry blends positivist elements (Groat & Wang, 2013, p. 77), such as measurable data from simulations and space syntax, with constructivism techniques (Groat & Wang, 2013, p. 76), such as observations and questionnaires, that capture user experiences and movement behaviors. This combination highlights the complexity of the subject, where both empirical data and human perception must be considered to fully understand the interaction between daylighting and library user movement.

The research methodology unfolds in several distinct phases to ensure a comprehensive evaluation of spatial dynamics and user interactions within the library. The primary approach integrates space syntax analysis with daylighting simulations, photographic documentation, direct observation, and user and librarian feedback through questionnaires and behavior mappings.

Initially, space syntax analysis is conducted using DepthMapX software to process a digitized floor plan of the libraries (Space Syntax Online, 2025). Key spatial indicators such as Connectivity through Angular Segment Analysis, and Visibility through Graph Analysis (VGA) are simulated using the software to understand how these variables influence movement and usage patterns as well as their possible overlap on daylighting condition. Heatmaps of these indicators visually represent high- and low-value regions, providing insights into spatial accessibility and user preferences. Concurrently, daylighting simulations are performed with Rhino + AnnuOWL plugin to assess natural light distribution throughout the library and gather data on useful daylight illuminance (UDI), Daylight Provision (DP), and daylight glare probability (DGP).

To enrich the spatial and lighting data, photographic documentation using an iPhone and DSLR camera will be employed to create luminance maps and capture space usage under various lighting conditions. Simultaneously, direct observation will track user navigation, seating preferences, and movement patterns over several days in October, November, and December. These observations will then be compared against space syntax and daylighting heatmaps to identify correlations between spatial characteristics, lighting conditions, and user behavior.

Additionally, a questionnaire survey collects qualitative feedback from librarians and staff about space usage, occupancy trends, and the impact of lighting on the environment. This qualitative feedback is crucial for understanding the subjective experiences of users, further illuminating how daylighting affects their movement and interactions within the library.

Based on the requirements, constraints, and objectives of this study, a diagram could be drawn that showcases different approaches toward data collection in this research (Fig. 12).

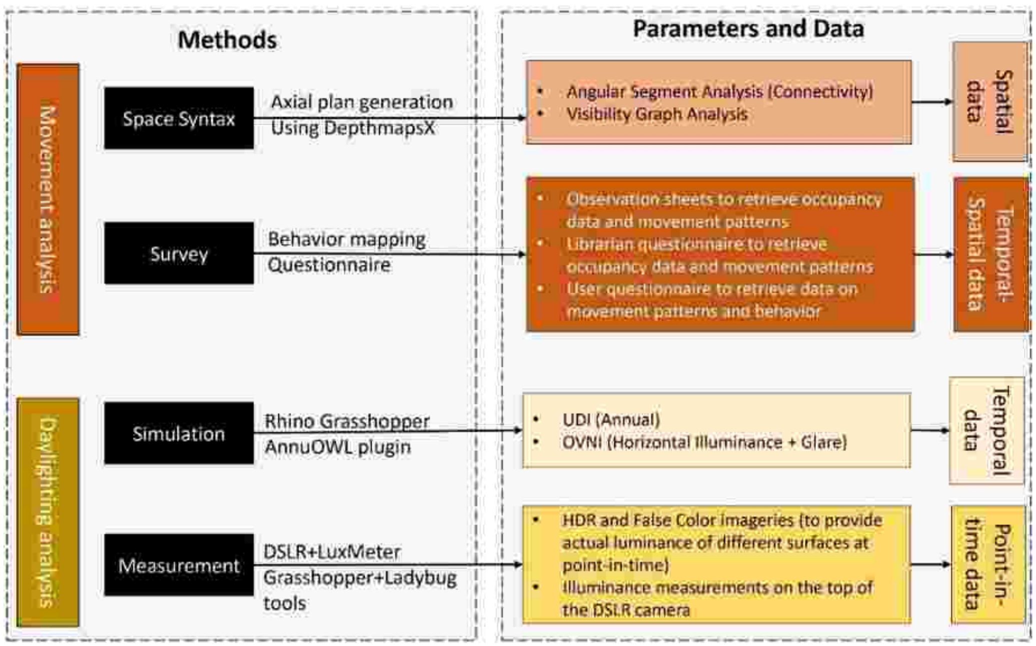

Figure 12. Diagram of the parameters of the research (Source: author).

The final phase of the research involves integrating and overlaying all data layers—space syntax, daylighting, observational, and questionnaire feedback—to identify patterns and synthesize a comprehensive understanding of how spatial layout and environmental conditions collectively influence library usage. This multi-layered approach provides a holistic view of the factors shaping user behavior in the library, offering valuable insights into the interplay between space, daylight, and human movement.

4.1. Methodological Validation through Comparative Analysis of Previous Studies

The research studies employed a range of methodologies to explore the impact of daylighting and architectural design on user experience and movement as outlined in the chapter of the literature review. Various methods were used, each providing unique insights into how these factors influence comfort and behavior in different settings. For this study, after reviewing all the methods employed in the studies discussed in the literature review chapter, and considering the feasibility, availability, and validity of the resources at disposal, 11 research studies were selected that served as key sources of inspiration for the methodology of this research. These studies were chosen based on their relevance to the investigation of daylighting and user movement, as well as their use of effective and practical methods that align with the objectives and constraints of this study (Table 3).

Table 3. References of the methods intended to be used in the research and have been previously tested (Source: author).

Parameters under investigation		Nature of the data	Methods or techniques of data collection	Output values	Research example
Movement	• Spatial accessibility • movement paths • layout connectivity • distance from key points • movement pattern complexity	Interval quantitative data	• Rhino 2D modleing + DepthmapsX Space syntax	Axial maps of Connectivity, Spatial Choice, Integration, Depth, and Entropy	Both et al. (2013), Saeidi et al. (2024)
Movement	• Occupation time • Occupation count • Movement direction • Table/seat selection	Interval quantitative data, and Ordinal qualitative data	• Observation • Questionnaire	Description with behavior map of the library users	Dubois et al. (2007), Kilic & Hasirci (2011), Izmir Tunahan et al. (2022)
Daylighting	• Daylighting experience	Nominal qualitative data	• Observation • HDR photography	Descriptions with photography documentation	Edwards (2011), Aram & Alibaba (2018)

	• Daylighting perception	Ordinal Qualitative data	• Questionnaire	Reports and spatial perception map	Izmir Tunahan et al. (2022), Aram & Alibaba (2018)
	• Daylighting condition	Interval quantitative data	• Daylight simulation	DF, sDA, DGP, UDI maps	Dabaj et al. (2022), Liu et al, (2023)
			• Daylight measurement	Point-in-time Illuminance levels map on the working plane	Arango-Díaz et al. (2022)
			• False color imagery	Luminance mapping	Jørgensen et al. (2012)

Behavior mapping was one of the primary techniques used (Fig. 13). For instance, Dubois et al. (2007) conducted behavior mapping in a café to observe user locations, activities, furniture types, and daylight conditions. Observations were made every 15 minutes to capture how different sky conditions, including clear, partially clear, and overcast, affected user behavior and comfort. Similarly, Omar et al. (2018) used observational methods in a library to understand seating preferences and the impact of daylight and views on these choices. They recorded seat preferences at different times of day and used this data to assess how daylight influences seating behavior and overall comfort.

Daylight simulations were another key methodological approach. Okwuosa et al. (2024) utilized Velux software to perform daylight simulations, focusing on how building design features impact daylight availability in library reading spaces. Liu et al. (2023) employed daylight simulation modeling with Rhino software to evaluate the lighting environment in library buildings, assessing performance based on design parameters. Dabaj et al. (2022) also used daylight simulations to study the effects of various shading devices and user positions on daylight performance and visual comfort in libraries.

Photography and luminance mapping were employed by several researchers to capture and analyze daylight conditions. Aram & Alibaba (2018) used photography to document daylighting effects in a university library, capturing random times to assess how daylight conditions influenced the environment. Jørgensen et al. (2012) combined HDR photography and luminance mapping with daylight factor (DF) measurements to investigate architectural strategies related to daylight in three Danish libraries, providing a detailed analysis of light distribution and its impact on the library spaces.

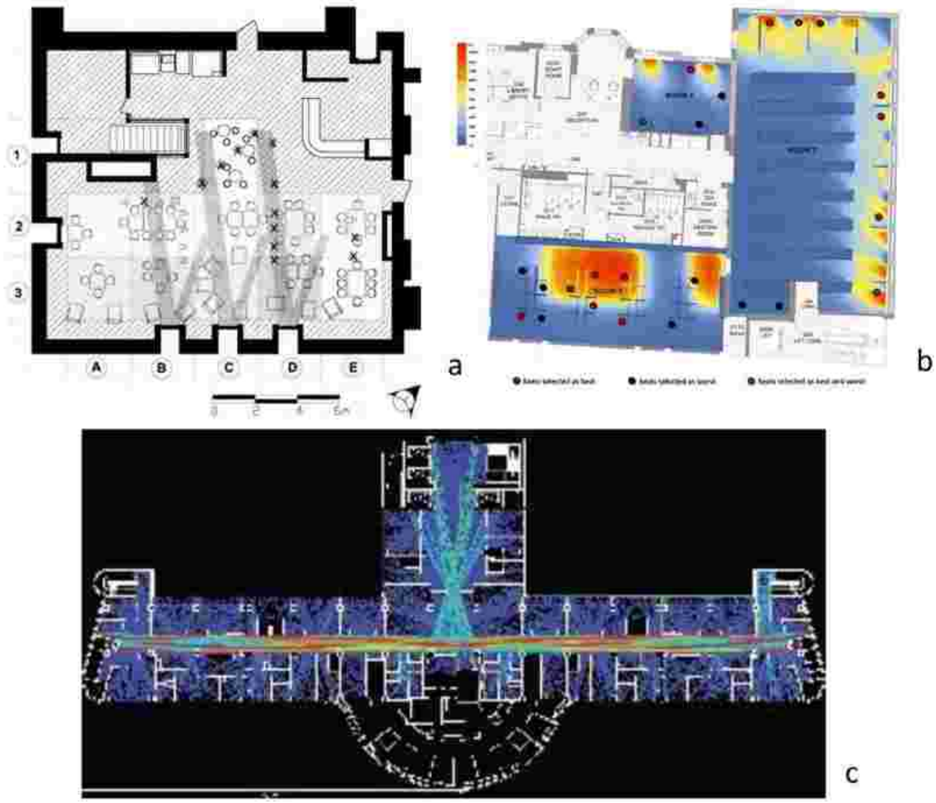

Figure 13. Three different approaches to map the behavior of users in a building based on observation (a) (source a: Dubois et al., 2007), questionnaire (b) (source b: Izmir Tunahan et al., 2022), and space syntax (e.g. choice value) (c) (source c: Saeidi et al., 2024).

Questionnaires and surveys were integral to many studies, offering valuable insights into user perceptions and preferences. Jørgensen et al. (2012) distributed a questionnaire with questions about room brightness, light and dark area variations, and open-ended inquiries about architecture and space use. Izmir Tunahan et al. (2022) conducted an experiment where 50 students filled out questionnaires on preferred and non-preferred seating, described daylight conditions, and delineated perceived daylit and non-daylit areas in a library. Omar et al. (2018) also used a detailed questionnaire with 35 questions to explore seating preferences, privacy, crowding, daylighting, and visual comfort, complementing their data with illuminance level measurements.

Experiments and user studies provided further insights. Izmir Tunahan et al. (2022) carried out an experiment involving 50 students who selected the best and worst seats in a library and described daylight conditions in relation to their choices. Saeidi et al. (2024) investigated user movement patterns in hospital wards using space syntax and axial maps, focusing on how path architecture complexity affects circulation and user navigation within healthcare environments.

Monitoring and measurements were also employed to assess daylight utilization and its impact. Omar et al. (2018) used HOBO dataloggers to monitor daylight utilization and measured illuminance levels with a light meter during their surveys, providing quantitative data on lighting conditions in the library setting. Kilic & Hasirci (2011) measured illuminance levels and administered questionnaires to study the effects of daylighting on user satisfaction in university libraries.

Finally, comparative case studies were used to understand broader design implications. Edwards (2011) performed comparative case studies to explore how physical and democratic openness in library design influences sustainability and user satisfaction, shedding light on the broader impacts of design choices on user experience.

These methodologies collectively offer a rich understanding of how daylighting and architectural design interact to affect user experience, providing a comprehensive approach to evaluating these factors across different building types (Table 4).

Table 4. Parameters and procedure of study in previous research (Source: author).

NO	Parameter of study	Procedure	Building type	Reference
1	• Seat selection • Choice of place • Occupancy map	• Behavior mapping: The location of the users within the café, the type of activity performed, the type of furniture used and the sky conditions (clear, partially clear and overcast) were noted every 15 minutes.	Library and Café	Izmir Tunahan et al. (2022). Dubois et al. (2007).
2	• Daylight condition (e.g. glare) • Daylighting strategies	• Observation and analysis: in the recorded random times of October to December. • Photography documentation: in the random times when observation took place	Library	Aram & Alibaba (2018).
3	• Building design features	• Daylight simulations with Velux and design recommendations	Library	Okwuosa et al. (2024).
4	• Experience • Architectural daylighting strategies	• Questionnaire: The questionnaire contained eight questions on the brightness of the room, the variation	Library	Jørgensen et al. (2012).

		between light and dark areas, and various open-ended questions about the architecture and the use of space. • HDR photography and luminance mapping with false color images • DF measurements • Narrative and description		
5	• Daylight simulation	• Library modeling with Rhino for daylight analysis	Library	Liu et al. (2023).
6	• Daylight simulation regarding user position	• Library modeling with Rhino+honeybee for daylight analysis	Library	Dabaj et al. (2022).
7	• Seat selection	• Experiment: An experiment was conducted with 50 students who were instructed to select the best and worst seats, describe the best desks' daylight conditions and draw boundary lines between perceived daylit and non-daylit spaces in a library.	Library	Izmir Tunahan et al. (2022).
8	• User behavior	• Monitoring	Library	Omar et al. (2018).
9	• Choose of seat • Circulation guidance • Crowding	• Observation: Conducted at 9 a.m., 1 p.m., and 5 p.m., recording seat preferences to understand how daylight and views affect seating choices. • Questionnaire: Administered to users while measuring light levels, with 35 questions on seating preferences, privacy, crowding, daylighting, and visual comfort, rated on a 1–5 scale. • Measurement: Illuminance levels were measured with a light meter during the questionnaire.	Library	Kilic, & Hasirci (2011).
10	• Physical openness	• Comparative case studies	Library	Edwards (2011).

	• Democratic openness			
11	• Connectivity, integration, depth, choice, entropy • Wayfinding	• Space syntax using DepthmapX to create axial maps and to understand the movement patterns of the users	Library and Hospital wards	Both et al. (2013). Saeidi et al. (2024).

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APPENDIX 2 – Approval Letter from the Ethics Committee

POLITECHNIKA GDAŃSKA

UCZELNIA BADAWCZA

Prorektor ds. nauki

30.01.2025 r.

RN 4/2025

Opinia

Kierując się powszechnie uznanymi zasadami prowadzenia badań naukowych wyrażonymi w dokumentach etycznych i prawnych krajowych i międzynarodowych stwierdzam, co następuje:

- w dniu 10.10.2024 r. wpłynął wniosek p. Mosleh Ahmadi o zaopiniowanie prac badawczych: *Wpływ oświetlenia dziennego na ruch użytkowników w architekturze: Badanie trójmiejskich lokalnych bibliotek publicznych w XXI wieku (od 2004 roku).*
- wniosek zawierał określenie celu badania, przebiegu procedur badawczych, informację o uczestnikach badania i wzór zgody uczestnika wraz z informacją o przechowywaniu danych uczestnika.
- do złożonego wniosku nie zgłaszam uwag.

Po zapoznaniu się z przedstawioną dokumentacją podejmuję decyzję o pozytywnym zaopiniowaniu ww. wniosku i nie zgłaszam zastrzeżeń do przedstawionego projektu badania.

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Uczelnie Fahrenheita

APPENDIX 3 – User Questionnaire Responses (Question 1)

No	User ID (Library, Month, Number)	Age	Gender	Occupation	Previous Questionnaire Completion	Library	Floor	Q1. Selected Location
1	Kack-DEC-001	50 to 64	Female	Employed	N/A	Maly Kack	Ground	6
2	Kack-DEC-002	30 to 49	Male	Employed	N/A	Maly Kack	Ground	4
3	Kack-DEC-003	12 to 17	Female	Student	N/A	Maly Kack	Ground	8
4	Kack-DEC-004	50 to 64	Female	Employed	N/A	Maly Kack	Ground	6
5	Kack-DEC-005	18 to 29	Female	Student	N/A	Maly Kack	First	11
6	Kack-DEC-006	30 to 49	Male	Employed	N/A	Maly Kack	Ground	3
7	Kack-DEC-007	30 to 49	Female	Employed	N/A	Maly Kack	First	12
8	Kack-DEC-008	18 to 29	Female	Student	N/A	Maly Kack	First	11
9	Kack-DEC-009	18 to 29	Female	Student	N/A	Maly Kack	First	17
10	Kack-DEC-010	12 to 17	Female	Student	N/A	Maly Kack	First	15
11	Kack-DEC-011	18 to 29	Female	Employed	N/A	Maly Kack	First	17
12	Kack-DEC-012	30 to 49	Male	Others	N/A	Maly Kack	First	14
13	Kack-DEC-013	30 to 49	Female	Others	N/A	Maly Kack	First	14
14	Kack-DEC-014	30 to 49	Male	Employed	N/A	Maly Kack	First	16
15	Kack-DEC-015	50 to 64	Female	Employed	N/A	Maly Kack	First	12
16	Kack-DEC-016	Under 12	Male	Others	N/A	Maly Kack	Ground	3
17	Kack-DEC-017	30 to 49	Male	Employed	N/A	Maly Kack	Ground	8
18	Kack-DEC-018	30 to 49	Female	Employed	N/A	Maly Kack	Ground	5
19	Kack-DEC-019	Under 12	Female	Student	N/A	Maly Kack	Ground	5
20	Kack-DEC-020	30 to 49	Female	Employed	N/A	Maly Kack	Ground	9
21	Kack-DEC-021	30 to 49	Male	Employed	N/A	Maly Kack	Ground	6
22	Kack-DEC-022	30 to 49	Female	Employed	N/A	Maly Kack	Ground	6
23	Kack-DEC-023	30 to 49	Male	Employed	N/A	Maly Kack	Ground	6
24	Kack-DEC-024	30 to 49	Female	Employed	N/A	Maly Kack	Ground	5
25	Kack-DEC-025	30 to 49	Female	Employed	N/A	Maly Kack	Ground	8
26	Kack-DEC-026	18 to 29	Male	Employed	N/A	Maly Kack	Ground	3
27	Kack-DEC-027	65 and above	Male	Retired	N/A	Maly Kack	Ground	7
28	Kack-DEC-028	30 to 49	Female	Others	N/A	Maly Kack	First	14
29	Kack-DEC-029	30 to 49	Female	Employed	N/A	Maly Kack	First	16
30	Wit-DEC-001	18 to 29	Male	Student	N/A	Witamino	Ground	4
31	Wit-DEC-002	12 to 17	Male	Student	N/A	Witamino	First	11
32	Wit-DEC-003	12 to 17	Male	Student	N/A	Witamino	First	20
33	Wit-DEC-004	12 to 17	Male	Student	N/A	Witamino	First	21
34	Wit-DEC-005	12 to 17	Male	Student	N/A	Witamino	First	10
35	Wit-JAN-006	30 to 49	Female	Employed	N/A	Witamino	First	11
36	Wit-JAN-007	12 to 17	Male	Student	N/A	Witamino	First	9
37	Wit-DEC-008	18 to 29	Female	Student	N/A	Witamino	Ground	2
38	Wit-DEC-009	18 to 29	Female	Others	N/A	Witamino	First	20
39	Wit-March-010	30 to 49	Male	Employed	No	Witamino	Ground	3
40	Wit-March-011	30 to 49	Male	Employed	No	Witamino	Ground	1
41	Wit-March-012	50 to 64	Male	Employed	No	Witamino	Ground	1
42	Wit-March-013	30 to 49	Female	Employed	No	Witamino	First	8
43	Wit-March-014	18 to 29	Female	Student	No	Witamino	First	21

44	Wit-March-015	18 to 29	Female	Others	No	Witamino	First	21
45	Wit-March-016	Under 12	Male	Others	No	Witamino	First	12
46	Wit-March-017	30 to 49	Male	Employed	No	Witamino	Ground	1
47	Wit-March-018	30 to 49	Male	Employed	No	Witamino	First	15
48	Wit-March-019	12 to 17	Female	Student	No	Witamino	First	10
49	Kack-FEB-030	18 to 29	Female	Student	N/A	Maly Kack	First	12
50	Kack-FEB-031	30 to 49	Female	Employed	N/A	Maly Kack	Ground	2
51	Kack-FEB-032	30 to 49	Male	Employed	N/A	Maly Kack	Ground	5
52	Kack-FEB-033	18 to 29	Female	Employed	N/A	Maly Kack	Ground	3
53	Kack-FEB-034	18 to 29	Female	Student	N/A	Maly Kack	First	15
54	Kack-FEB-035	12 to 17	Female	Others	N/A	Maly Kack	Ground	7
55	Kack-FEB-036	30 to 49	Female	Employed	N/A	Maly Kack	Ground	2
56	Kack-FEB-037	30 to 49	Female	Student	N/A	Maly Kack	Ground	6
57	Kack-FEB-038	50 to 64	Female	Employed	N/A	Maly Kack	Ground	2
58	Kack-FEB-039	Under 12	Female	Others	N/A	Maly Kack	Ground	8
59	Kack-FEB-040	Under 12	Female	Others	N/A	Maly Kack	Ground	6
60	Kack-FEB-041	Under 12	Male	Others	N/A	Maly Kack	Ground	6
61	Kack-FEB-042	30 to 49	Female	Employed	N/A	Maly Kack	First	13
62	Kack-FEB-043	18 to 29	Female	Student	N/A	Maly Kack	Ground	6
63	Kack-FEB-044	18 to 29	Non-binary	Student	N/A	Maly Kack	First	14
64	Kack-FEB-045	30 to 49	Male	Employed	N/A	Maly Kack	Ground	3
65	Kack-FEB-046	30 to 49	Female	Employed	N/A	Maly Kack	Ground	9
66	Kack-FEB-047	Under 12	Male	Student	N/A	Maly Kack	Ground	14
67	Kack-FEB-048	12 to 17	Male	Others	N/A	Maly Kack	Ground	4
68	Kack-March-049	18 to 29	Female	Student	No	Maly Kack	First	14
69	Kack-March-050	30 to 49	Male	Others	No	Maly Kack	First	14
70	Kack-March-051	30 to 49	Female	Others	No	Maly Kack	Ground	5
71	Kack-March-052	18 to 29	Female	Student	No	Maly Kack	First	17
72	Kack-March-053	18 to 29	Female	Student	In winter	Maly Kack	First	11
73	Kack-March-054	30 to 49	Male	Others	No	Maly Kack	Ground	3
74	Kack-March-055	50 to 64	Female	Employed	No	Maly Kack	Ground	2
75	Kack-March-056	50 to 64	Female	Others	No	Maly Kack	Ground	7
76	Kack-March-057	30 to 49	Female	Employed	No	Maly Kack	Ground	2
77	Kack-March-058	30 to 49	Male	Employed	No	Maly Kack	Ground	4
78	Kack-March-059	30 to 49	Female	Employed	No	Maly Kack	First	11
79	Kack-March-060	30 to 49	Male	Employed	No	Maly Kack	Ground	7
80	Kack-March-061	30 to 49	Female	Employed	In winter	Maly Kack	First	11
81	Kack-March-062	18 to 29	Female	Employed	No	Maly Kack	First	11
82	Kack-March-063	30 to 49	Female	Employed	No	Maly Kack	First	5
83	Kack-March-064	30 to 49	Female	Employed	No	Maly Kack	Ground	7
84	Kack-March-065	50 to 64	Female	Others	No	Maly Kack	Ground	7
85	Kack-March-066	30 to 49	Female	Employed	No	Maly Kack	Ground	9
86	Kack-March-067	12 to 17	Female	Others	No	Maly Kack	Ground	3
87	Kack-March-068	18 to 29	Male	Employed	No	Maly Kack	Ground	2
88	Kack-March-069	30 to 49	Female	Others	No	Maly Kack	Ground	5
89	Kack-March-070	12 to 17	Male	Others	No	Maly Kack	Ground	5
90	Kack-March-071	30 to 49	Female	Employed	No	Maly Kack	Ground	5
91	Kack-March-072	30 to 49	Female	Others	No	Maly Kack	Ground	8
92	Kack-March-073	18 to 29	Female	Student	No	Maly Kack	Ground	14

93	Wit-June-020	30 to 49	Male	Employed	No	Witamino	Ground	4
94	Wit-June-021	30 to 49	Female	Employed	No	Witamino	Ground	1
95	Wit-June-022	30 to 49	Female	Employed	No	Witamino	First	8
96	Wit-June-023	12 to 17	Male	Others	No	Witamino	First	12
97	Wit-June-024	18 to 29	Female	Others	In spring	Witamino	First	21
98	Wit-June-025	18 to 29	Female	Student	No	Witamino	First	20
99	Wit-June-026	Under 12	Male	Others	In spring	Witamino	First	12
100	Wit-June-027	50 to 64	Male	Others	In spring	Witamino	Ground	3
101	Wit-June-028	30 to 49	Male	Others	No	Witamino	First	13
102	Wit-June-029	18 to 29	Female	Student	No	Witamino	First	10
103	Kack-June-074	Under 12	Male	Student	No	Maly Kack	Ground	3
104	Kack-June-075	12 to 17	Female	Student	No	Maly Kack	First	11
105	Kack-June-076	30 to 49	Male	Others	No	Maly Kack	First	17
106	Kack-June-077	12 to 17	Female	Others	No	Maly Kack	First	11
107	Kack-June-078	12 to 17	Female	Student	No	Maly Kack	First	11
108	Kack-June-079	18 to 29	Female	Student	No	Maly Kack	First	14
109	Kack-June-080	18 to 29	Male	Others	No	Maly Kack	First	16
110	Kack-June-081	30 to 49	Male	Others	No	Maly Kack	First	8
111	Kack-June-082	Under 12	Male	Student	No	Maly Kack	Ground	4
112	Kack-June-083	30 to 49	Male	Student	In winter	Maly Kack	Ground	1
113	Kack-June-084	50 to 64	Female	Employed	In winter	Maly Kack	Ground	5
114	Kack-June-085	18 to 29	Female	Employed	No	Maly Kack	First	11
115	Kack-June-086	30 to 49	Female	Employed	No	Maly Kack	Ground	10
116	Kack-June-087	18 to 29	Male	Student	No	Maly Kack	First	13
117	Kack-June-088	18 to 29	Female	Student	No	Maly Kack	First	11
118	Kack-June-089	30 to 49	Female	Employed	No	Maly Kack	First	12

APPENDIX 3 – User Questionnaire Responses (Question 2)

No	User ID (Library, Month, Number)	Q2. Better Daylighting Condition	Q2. Better electrical lighting condition	Q2. Avoiding noise	Q2. Privacy and isolation	Q2. Comfortable seating	Q2. View out
1	Kack-DEC-001	0	0	0	1	0	0
2	Kack-DEC-002	1	1	0	0	1	0
3	Kack-DEC-003	0	0	1	1	1	0
4	Kack-DEC-004	0	0	0	0	0	1
5	Kack-DEC-005	0	0	1	0	1	0
6	Kack-DEC-006	1	1	0	0	1	0
7	Kack-DEC-007	0	0	1	0	1	0
8	Kack-DEC-008	0	0	1	1	1	0
9	Kack-DEC-009	1	0	0	0	1	0
10	Kack-DEC-010	0	0	1	1	1	0
11	Kack-DEC-011	0	0	0	0	1	0
12	Kack-DEC-012	0	0	0	1	1	0
13	Kack-DEC-013	0	0	1	1	0	0
14	Kack-DEC-014	0	0	0	1	1	1
15	Kack-DEC-015	1	0	1	0	1	0
16	Kack-DEC-016	0	1	1	1	1	1
17	Kack-DEC-017	0	1	0	0	0	0
18	Kack-DEC-018	0	0	0	0	0	0
19	Kack-DEC-019	1	1	1	1	1	1
20	Kack-DEC-020	0	0	0	1	0	0
21	Kack-DEC-021	0	0	0	0	0	0
22	Kack-DEC-022	0	1	0	0	1	0
23	Kack-DEC-023	0	0	0	0	0	0
24	Kack-DEC-024	1	0	0	0	0	0
25	Kack-DEC-025	0	0	0	0	0	0
26	Kack-DEC-026	0	0	0	0	1	0
27	Kack-DEC-027	0	1	0	0	0	0
28	Kack-DEC-028	0	0	0	1	1	0
29	Kack-DEC-029	0	1	0	0	1	0
30	Wit-DEC-001	1	1	0	1	1	0
31	Wit-DEC-002	0	0	0	0	1	0
32	Wit-DEC-003	0	0	0	0	1	0
33	Wit-DEC-004	0	0	1	0	0	0
34	Wit-DEC-005	1	0	0	0	1	1
35	Wit-JAN-006	1	1	1	0	1	1
36	Wit-JAN-007	0	0	1	0	1	0
37	Wit-DEC-008	1	0	0	0	0	1
38	Wit-DEC-009	0	0	1	1	1	0
39	Wit-March-010	0	0	0	0	0	0
40	Wit-March-011	1	0	0	0	0	0
41	Wit-March-012	0	1	1	0	1	0
42	Wit-March-013	0	0	0	0	0	0
43	Wit-March-014	1	0	1	1	0	1

44	Wit-March-015	1	0	1	1	1	0
45	Wit-March-016	0	0	0	1	0	1
46	Wit-March-017	1	1	0	0	1	0
47	Wit-March-018	1	1	0	0	0	0
48	Wit-March-019	1	0	1	1	1	1
49	Kack-FEB-030	1	0	0	1	1	0
50	Kack-FEB-031	0	0	0	1	0	0
51	Kack-FEB-032	1	0	0	0	0	1
52	Kack-FEB-033	1	0	1	1	1	1
53	Kack-FEB-034	0	1	0	0	1	0
54	Kack-FEB-035	0	0	0	0	1	1
55	Kack-FEB-036	0	0	0	0	0	0
56	Kack-FEB-037	0	0	1	0	0	0
57	Kack-FEB-038	0	0	0	1	1	0
58	Kack-FEB-039	0	0	0	0	1	1
59	Kack-FEB-040	0	0	1	1	0	0
60	Kack-FEB-041	0	0	1	0	0	1
61	Kack-FEB-042	0	0	0	1	1	0
62	Kack-FEB-043	1	0	1	1	0	1
63	Kack-FEB-044	0	0	0	0	1	0
64	Kack-FEB-045	1	0	0	0	1	0
65	Kack-FEB-046	0	0	0	1	1	0
66	Kack-FEB-047	0	0	0	0	1	0
67	Kack-FEB-048	0	0	0	0	1	0
68	Kack-March-049	0	0	0	1	0	0
69	Kack-March-050	0	0	0	1	0	0
70	Kack-March-051	1	1	0	0	0	1
71	Kack-March-052	1	0	1	1	1	1
72	Kack-March-053	0	0	1	1	1	0
73	Kack-March-054	0	0	0	0	1	0
74	Kack-March-055	0	0	0	1	0	1
75	Kack-March-056	0	0	0	0	0	0
76	Kack-March-057	1	0	0	0	0	0
77	Kack-March-058	0	0	0	0	0	0
78	Kack-March-059	1	0	0	0	0	0
79	Kack-March-060	1	0	0	1	0	1
80	Kack-March-061	0	0	1	1	1	0
81	Kack-March-062	0	0	1	1	1	0
82	Kack-March-063	1	1	1	1	1	0
83	Kack-March-064	1	0	0	0	0	1
84	Kack-March-065	1	0	0	0	1	1
85	Kack-March-066	0	0	0	1	0	0
86	Kack-March-067	0	0	1	1	1	1
87	Kack-March-068	1	0	1	1	0	0
88	Kack-March-069	0	0	0	0	1	0
89	Kack-March-070	1	0	0	0	0	1
90	Kack-March-071	1	0	1	1	0	1
91	Kack-March-072	1	0	1	0	0	0
92	Kack-March-073	0	0	0	1	0	0
93	Wit-June-020	0	0	0	1	0	0

94	Wit-June-021	0	0	0	0	1	1
95	Wit-June-022	1	0	0	0	0	0
96	Wit-June-023	1	0	1	0	1	1
97	Wit-June-024	1	0	1	1	0	0
98	Wit-June-025	1	0	1	0	1	0
99	Wit-June-026	1	0	0	1	1	1
100	Wit-June-027	1	0	1	0	0	0
101	Wit-June-028	1	1	0	1	1	0
102	Wit-June-029	1	0	0	0	1	1
103	Kack-June-074	0	0	1	1	1	0
104	Kack-June-075	0	0	1	1	1	0
105	Kack-June-076	0	0	0	1	0	0
106	Kack-June-077	0	0	0	1	1	0
107	Kack-June-078	0	0	1	1	1	0
108	Kack-June-079	1	1	1	1	0	0
109	Kack-June-080	0	0	0	1	1	0
110	Kack-June-081	1	0	0	0	0	1
111	Kack-June-082	0	0	1	1	0	0
112	Kack-June-083	0	1	0	0	1	0
113	Kack-June-084	1	0	0	1	0	1
114	Kack-June-085	0	0	1	1	1	0
115	Kack-June-086	0	0	0	1	0	0
116	Kack-June-087	1	0	0	0	1	0
117	Kack-June-088	0	1	1	1	0	0
118	Kack-June-089	0	0	1	1	0	0

APPENDIX 3 – User Questionnaire Responses (Questions 2-4)

No	User ID (Library, Month, Number)	Q2. Access to electricity or computer	Q2. Access to books, shelves, or reception	Q3. Sky type	Q4. Date	Q4. Time	Q4. Time Period
1	Kack-DEC-001	0	1	Partly cloudy sky	12/10/2024	11:00:00 AM	Morning
2	Kack-DEC-002	1	1	Overcast sky	12/7/2024	11:10:00 AM	Morning
3	Kack-DEC-003	0	1	Overcast sky	12/5/2024	4:41:00 PM	Afternoon
4	Kack-DEC-004	1	1	Overcast sky	12/4/2024	3:50:00 PM	Afternoon
5	Kack-DEC-005	0	0	Overcast sky	12/10/2024	4:46:00 PM	Afternoon
6	Kack-DEC-006	0	0	Overcast sky	12/7/2024	12:30:00 PM	Noon
7	Kack-DEC-007	0	0	Partly cloudy sky	12/7/2024	1:00:00 PM	Noon
8	Kack-DEC-008	0	0	Partly cloudy sky	12/7/2024	11:23:00 AM	Morning
9	Kack-DEC-009	0	0	Overcast sky	12/7/2024	9:56:00 AM	Morning
10	Kack-DEC-010	0	1	Overcast sky	12/5/2024	4:42:00 PM	Afternoon
11	Kack-DEC-011	0	0	Overcast sky	12/5/2024	1:40:00 PM	Noon
12	Kack-DEC-012	1	0	Clear sky	12/5/2024	12:14:00 PM	Noon
13	Kack-DEC-013	0	0	Overcast sky	12/10/2024	5:05:00 PM	Afternoon
14	Kack-DEC-014	1	1	Overcast sky	12/10/2024	5:00:00 PM	Afternoon
15	Kack-DEC-015	0	1	Clear sky	12/12/2024	10:28:00 AM	Morning
16	Kack-DEC-016	1	1	Partly cloudy sky	12/12/2024	3:18:00 PM	Afternoon
17	Kack-DEC-017	0	0	Partly cloudy sky	12/12/2024	3:00:00 PM	Afternoon
18	Kack-DEC-018	0	1	Partly cloudy sky	12/4/2024	1:30:00 PM	Noon
19	Kack-DEC-019	1	1	Overcast sky	12/12/2024	3:13:00 PM	Afternoon
20	Kack-DEC-020	0	0	Partly cloudy sky	12/12/2024	11:00:00 AM	Morning
21	Kack-DEC-021	1	0	Partly cloudy sky	12/10/2024	5:00:00 PM	Afternoon
22	Kack-DEC-022	0	1	Overcast sky	12/10/2024	4:54:00 PM	Afternoon
23	Kack-DEC-023	0	1	Overcast sky	12/6/2024	5:30:00 PM	Afternoon
24	Kack-DEC-024	0	0	Overcast sky	12/7/2024	12:31:00 PM	Noon
25	Kack-DEC-025	0	1	Overcast sky	12/7/2024	12:35:00 PM	Noon
26	Kack-DEC-026	0	1	Overcast sky	12/7/2024	11:05:00 AM	Morning
27	Kack-DEC-027	0	0	Overcast sky	12/10/2024	5:00:00 PM	Afternoon
28	Kack-DEC-028	0	0	Clear sky	12/11/2024	4:00:00 PM	Afternoon
29	Kack-DEC-029	0	1	Overcast sky	12/10/2024	5:10:00 PM	Afternoon
30	Wit-DEC-001	1	0	Overcast sky	12/9/2024	11:00:00 AM	Morning
31	Wit-DEC-002	0	0	Clear sky	12/13/2024	11:45:00 AM	Morning
32	Wit-DEC-003	1	1	Clear sky	12/13/2024	11:45:00 AM	Morning
33	Wit-DEC-004	0	0	Clear sky	12/13/2024	11:45:00 AM	Morning
34	Wit-DEC-005	0	0	Clear sky	12/13/2024	11:47:00 AM	Morning
35	Wit-JAN-006	0	0	Partly cloudy sky	17/01/2025	3:00:00 PM	Afternoon
36	Wit-JAN-007	0	0	Clear sky	12/13/2024	11:57:00 AM	Morning
37	Wit-DEC-008	0	1	Clear sky	25/01/2025	1:00:00 PM	Noon
38	Wit-DEC-009	0	0	Partly cloudy sky	16/01/2025	2:00:00 PM	Noon
39	Wit-March-010	1	0	Partly cloudy sky	10/3/2025	12:00:00 PM	Morning
40	Wit-March-011	0	0	Clear sky	10/3/2025	1:00:00 PM	Noon
41	Wit-March-012	0	0	Clear sky	14/3/2025	12:30:00 PM	Noon
42	Wit-March-013	0	1	Clear sky	14/3/2025	12:30:00 PM	Noon
43	Wit-March-014	1	0	Overcast sky	13/3/2025	10:15:00 AM	Morning
44	Wit-March-015	1	0	Clear sky	10/3/2025	3:30:00 PM	Afternoon
45	Wit-March-016	0	0	Clear sky	10/3/2025	11:30:00 AM	Morning
46	Wit-March-017	0	0	Clear sky	15/3/2025	11:30:00 AM	Morning

47	Wit-March-018	0	0	Clear sky	14/3/2025	12:10:00 PM	Noon
48	Wit-March-019	0	0	Partly cloudy sky	18/3/2025	1:50:00 PM	Noon
49	Kack-FEB-030	0	1	Partly cloudy sky	10/2/2025	5:05:00 PM	Afternoon
50	Kack-FEB-031	0	0	Overcast sky	3/2/2025	2:25:00 PM	Noon
51	Kack-FEB-032	0	0	Clear sky	10/2/2025	4:30:00 PM	Afternoon
52	Kack-FEB-033	0	0	Clear sky	18/2/2025	2:00:00 PM	Noon
53	Kack-FEB-034	0	0	Overcast sky	10/2/2025	5:05:00 PM	Afternoon
54	Kack-FEB-035	0	0	Partly cloudy sky	3/2/2025	3:10:00 PM	Afternoon
55	Kack-FEB-036	0	1	Clear sky	10/2/2025	4:40:00 PM	Afternoon
56	Kack-FEB-037	0	0	Clear sky	3/2/2025	2:00:00 PM	Noon
57	Kack-FEB-038	0	0	Partly cloudy sky	2/3/2025	11:00:00 AM	Morning
58	Kack-FEB-039	1	1	Partly cloudy sky	8/2/2025	9:15:00 AM	Morning
59	Kack-FEB-040	1	1	Partly cloudy sky	8/2/2025	9:15:00 AM	Morning
60	Kack-FEB-041	1	1	Partly cloudy sky	31/1/2025	10:00:00 AM	Morning
61	Kack-FEB-042	0	0	Overcast sky	3/2/2025	4:20:00 PM	Afternoon
62	Kack-FEB-043	0	0	Partly cloudy sky	6/2/2025	12:05:00 PM	Noon
63	Kack-FEB-044	0	0	Partly cloudy sky	3/2/2025	4:05:00 PM	Afternoon
64	Kack-FEB-045	0	1	Clear sky	6/2/2025	12:05:00 PM	Noon
65	Kack-FEB-046	0	0	Overcast sky	7/2/2025	12:00:00 PM	Noon
66	Kack-FEB-047	0	0	Partly cloudy sky	3/2/2025	11:40:00 AM	Morning
67	Kack-FEB-048	1	0	Overcast sky	3/2/2025	4:00:00 PM	Afternoon
68	Kack-March-049	0	0	Partly cloudy sky	17/03/2025	11:30:00 AM	Morning
69	Kack-March-050	0	1	Partly cloudy sky	28/03/2025	11:15:00 AM	Morning
70	Kack-March-051	0	0	Clear sky	20/03/2025	12:10:00 PM	Noon
71	Kack-March-052	0	0	Clear sky	20/03/2025	4:35:00 PM	Afternoon
72	Kack-March-053	0	0	Clear sky	20/03/2025	4:30:00 PM	Afternoon
73	Kack-March-054	0	0	Clear sky	20/03/2025	4:35:00 PM	Afternoon
74	Kack-March-055	0	0	Clear sky	26/3/2025	4:50:00 PM	Afternoon
75	Kack-March-056	0	1	Clear sky	20/03/2025	4:30:00 PM	Afternoon
76	Kack-March-057	0	0	Clear sky	20/03/2025	4:50:00 PM	Afternoon
77	Kack-March-058	0	1	Clear sky	20/03/2025	4:30:00 PM	Afternoon
78	Kack-March-059	0	0	Clear sky	20/03/2025	4:15:00 PM	Afternoon
79	Kack-March-060	1	0	Clear sky	11/3/2025	12:30:00 PM	Noon
80	Kack-March-061	0	0	Clear sky	18/03/2025	11:50:00 PM	Afternoon
81	Kack-March-062	1	0	Clear sky	18/03/2025	4:00:00 PM	Afternoon
82	Kack-March-063	0	1	Clear sky	19/03/2025	3:30:00 PM	Afternoon
83	Kack-March-064	0	0	Clear sky	17/03/2025	4:00:00 PM	Afternoon
84	Kack-March-065	0	0	Clear sky	18/03/2025	3:30:00 PM	Afternoon
85	Kack-March-066	1	0	Clear sky	18/03/2025	10:10:00 AM	Morning
86	Kack-March-067	1	1	Clear sky	19/03/2025	3:40:00 PM	Afternoon
87	Kack-March-068	0	0	Clear sky	30/03/2025	12:30:00 PM	Noon
88	Kack-March-069	1	1	Clear sky	17/03/2025	1:10:00 PM	Noon
89	Kack-March-070	0	0	Clear sky	17/03/2025	3:35:00 PM	Afternoon
90	Kack-March-071	0	1	Clear sky	17/03/2025	3:35:00 PM	Afternoon
91	Kack-March-072	0	1	Partly cloudy sky	11/3/2025	3:30:00 PM	Afternoon
92	Kack-March-073	1	0	Partly cloudy sky	17/03/2025	11:20:00 AM	Morning
93	Wit-June-020	1	0	Partly cloudy sky	17/06/205	1:07:00 PM	Noon
94	Wit-June-021	0	0	Clear sky	17/06/2025	5:40:00 PM	Afternoon
95	Wit-June-022	0	0	Partly cloudy sky	17/06/2025	4:30:00 PM	Afternoon
96	Wit-June-023	0	0	Partly cloudy sky	17/06/2025	1:07:00 PM	Noon
97	Wit-June-024	1	0	Partly cloudy sky	17/06/2025	4:30:00 PM	Afternoon
98	Wit-June-025	1	0	Partly cloudy sky	9/6/2025	4:25:00 PM	Afternoon

99	Wit-June-026	1	0	Clear sky	9/6/2025	1:15:00 PM	Noon
100	Wit-June-027	1	0	Clear sky	13/06/2025	11:00:00 AM	Morning
101	Wit-June-028	0	0	Overcast sky	18/06/2025	2:12:00 PM	Noon
102	Wit-June-029	0	0	Clear sky	20/06/2025	1:00:00 PM	Noon
103	Kack-June-074	0	1	Partly cloudy sky	12/6/2025	3:30:00 PM	Afternoon
104	Kack-June-075	0	0	Partly cloudy sky	11/6/2025	3:35:00 PM	Afternoon
105	Kack-June-076	0	0	Clear sky	13/06/2025	11:43:00 AM	Morning
106	Kack-June-077	0	1	Clear sky	12/6/2025	2:43:00 PM	Noon
107	Kack-June-078	0	1	Clear sky	12/6/2025	2:45:00 PM	Noon
108	Kack-June-079	1	0	Clear sky	9/6/2025	2:03:00 PM	Noon
109	Kack-June-080	0	1	Partly cloudy sky	11/6/2025	2:11:00 PM	Noon
110	Kack-June-081	0	1	Partly cloudy sky	9/6/2025	2:00:00 PM	Noon
111	Kack-June-082	1	0	Partly cloudy sky	12/6/2025	3:19:00 PM	Afternoon
112	Kack-June-083	1	0	Clear sky	20/6/2025	1:00:00 PM	Noon
113	Kack-June-084	0	0	Clear sky	20/6/2025	11:28:00 AM	Morning
114	Kack-June-085	0	0	Clear sky	20/06/2025	11:23:00 AM	Morning
115	Kack-June-086	1	0	Clear sky	21/6/2025	11:00:00 AM	Morning
116	Kack-June-087	1	0	Clear sky	20/6/2025	2:00:00 PM	Noon
117	Kack-June-088	0	0	Clear sky	20/6/2025	6:00:00 PM	Afternoon
118	Kack-June-089	0	1	Clear sky	20/6/2025	11:17:00 AM	Morning

APPENDIX 3 – User Questionnaire Responses (Questions 4-7)

No	User ID (Library, Month, Number)	Q4. Month	Q5. Current lighting condition in the location	Q6. Access to view-out	Q7. View-out satisfaction
1	Kack-DEC-001	Dec	A mix of daylight and artificial lighting, with more natural daylight	Yes	Yes
2	Kack-DEC-002	Dec	A mix of artificial lighting and daylight, with more artificial lighting	Yes	Yes
3	Kack-DEC-003	Dec	Only artificial lighting	N/A	N/A
4	Kack-DEC-004	Dec	Only artificial lighting	Yes	No
5	Kack-DEC-005	Dec	Only artificial lighting	No	N/A
6	Kack-DEC-006	Dec	A mix of artificial lighting and daylight, with more artificial lighting	Yes	Yes
7	Kack-DEC-007	Dec	Only artificial lighting	No	N/A
8	Kack-DEC-008	Dec	A mix of artificial lighting and daylight, with more artificial lighting	No	N/A
9	Kack-DEC-009	Dec	A mix of artificial lighting and daylight, with more artificial lighting	No	Yes
10	Kack-DEC-010	Dec	Only artificial lighting	No	Yes
11	Kack-DEC-011	Dec	A mix of artificial lighting and daylight, with more artificial lighting	Yes	No
12	Kack-DEC-012	Dec	A mix of artificial lighting and daylight, with more artificial lighting	Yes	Yes
13	Kack-DEC-013	Dec	Only artificial lighting	No	N/A
14	Kack-DEC-014	Dec	Only artificial lighting	No	N/A
15	Kack-DEC-015	Dec	A mix of daylight and artificial lighting, with more natural daylight	No	Yes
16	Kack-DEC-016	Dec	A mix of artificial lighting and daylight, with more artificial lighting	Yes	Yes
17	Kack-DEC-017	Dec	A mix of artificial lighting and daylight, with more artificial lighting	Yes	Yes
18	Kack-DEC-018	Dec	A mix of artificial lighting and daylight, with more artificial lighting	Yes	Yes
19	Kack-DEC-019	Dec	Only artificial lighting	Yes	Yes
20	Kack-DEC-020	Dec	A mix of daylight and artificial lighting, with more natural daylight	Yes	Yes
21	Kack-DEC-021	Dec	Only artificial lighting	Yes	Yes
22	Kack-DEC-022	Dec	Only artificial lighting	Yes	No
23	Kack-DEC-023	Dec	Only artificial lighting	Yes	No
24	Kack-DEC-024	Dec	A mix of artificial lighting and daylight, with more artificial lighting	Yes	No
25	Kack-DEC-025	Dec	A mix of artificial lighting and daylight, with more artificial lighting	Yes	Yes
26	Kack-DEC-026	Dec	Only artificial lighting	Yes	Yes
27	Kack-DEC-027	Dec	A mix of daylight and artificial lighting, with more natural daylight	Yes	Yes
28	Kack-DEC-028	Dec	A mix of artificial lighting and daylight, with more artificial lighting	No	N/A
29	Kack-DEC-029	Dec	Only artificial lighting	No	N/A
30	Wit-DEC-001	Dec	A mix of artificial lighting and daylight, with more artificial lighting	Yes	No
31	Wit-DEC-002	Dec	Only natural daylight	Yes	Yes
32	Wit-DEC-003	Dec	Only natural daylight	Yes	No
33	Wit-DEC-004	Dec	Only natural daylight	Yes	Yes
34	Wit-DEC-005	Dec	Only natural daylight	Yes	Yes
35	Wit-JAN-006	Jan	A mix of daylight and artificial lighting, with more natural daylight	Yes	Yes
36	Wit-JAN-007	Dec	A mix of daylight and artificial lighting, with more natural daylight	Yes	No
37	Wit-DEC-008	Dec	A mix of daylight and artificial lighting, with more natural daylight	Yes	Yes
38	Wit-DEC-009	Dec	A mix of daylight and artificial lighting, with more natural daylight	Yes	No
39	Wit-March-010	March	A mix of daylight and artificial lighting, with more natural daylight	No	N/A
40	Wit-March-011	March	A mix of daylight and artificial lighting, with more natural daylight	Yes	Yes
41	Wit-March-012	March	A mix of artificial lighting and daylight, with more artificial lighting	No	N/A
42	Wit-March-013	March	Only natural daylight	Yes	Yes
43	Wit-March-014	March	Only natural daylight	Yes	Yes
44	Wit-March-015	March	Only natural daylight	Yes	No
45	Wit-March-016	March	Only natural daylight	Yes	Yes
46	Wit-March-017	March	A mix of daylight and artificial lighting, with more natural daylight	Yes	Yes
47	Wit-March-018	March	A mix of daylight and artificial lighting, with more natural daylight	Yes	No
48	Wit-March-019	March	A mix of daylight and artificial lighting, with more natural daylight	Yes	Yes
49	Kack-FEB-030	Feb	Only artificial lighting	Yes	Yes

50	Kack-FEB-031	Feb	A mix of artificial lighting and daylight, with more artificial lighting	No	N/A
51	Kack-FEB-032	Feb	A mix of daylight and artificial lighting, with more natural daylight	Yes	Yes
52	Kack-FEB-033	Feb	A mix of daylight and artificial lighting, with more natural daylight	Yes	Yes
53	Kack-FEB-034	Feb	Only artificial lighting	No	No
54	Kack-FEB-035	Feb	A mix of artificial lighting and daylight, with more artificial lighting	Yes	Yes
55	Kack-FEB-036	Feb	A mix of artificial lighting and daylight, with more artificial lighting	Yes	Yes
56	Kack-FEB-037	Feb	A mix of artificial lighting and daylight, with more artificial lighting	Yes	Yes
57	Kack-FEB-038	Feb	A mix of artificial lighting and daylight, with more artificial lighting	Yes	Yes
58	Kack-FEB-039	Feb	Only natural daylight	Yes	Yes
59	Kack-FEB-040	Feb	Only natural daylight	Yes	Yes
60	Kack-FEB-041	Feb	Only natural daylight	Yes	Yes
61	Kack-FEB-042	Feb	Only artificial lighting	No	Yes
62	Kack-FEB-043	Feb	A mix of artificial lighting and daylight, with more artificial lighting	Yes	Yes
63	Kack-FEB-044	Feb	A mix of artificial lighting and daylight, with more artificial lighting	No	N/A
64	Kack-FEB-045	Feb	Only natural daylight	Yes	Yes
65	Kack-FEB-046	Feb	A mix of artificial lighting and daylight, with more artificial lighting	Yes	Yes
66	Kack-FEB-047	Feb	A mix of artificial lighting and daylight, with more artificial lighting	No	Yes
67	Kack-FEB-048	Feb	A mix of artificial lighting and daylight, with more artificial lighting	Yes	Yes
68	Kack-March-049	March	A mix of artificial lighting and daylight, with more artificial lighting	No	N/A
69	Kack-March-050	March	A mix of daylight and artificial lighting, with more natural daylight	No	N/A
70	Kack-March-051	March	Only natural daylight	Yes	Yes
71	Kack-March-052	March	A mix of artificial lighting and daylight, with more artificial lighting	No	N/A
72	Kack-March-053	March	A mix of daylight and artificial lighting, with more natural daylight	No	N/A
73	Kack-March-054	March	A mix of daylight and artificial lighting, with more natural daylight	Yes	No
74	Kack-March-055	March	Only natural daylight	Yes	No
75	Kack-March-056	March	A mix of daylight and artificial lighting, with more natural daylight	Yes	Yes
76	Kack-March-057	March	A mix of daylight and artificial lighting, with more natural daylight	Yes	Yes
77	Kack-March-058	March	A mix of daylight and artificial lighting, with more natural daylight	Yes	Yes
78	Kack-March-059	March	A mix of daylight and artificial lighting, with more natural daylight	Yes	Yes
79	Kack-March-060	March	Only natural daylight	Yes	Yes
80	Kack-March-061	March	A mix of artificial lighting and daylight, with more artificial lighting	No	N/A
81	Kack-March-062	March	A mix of artificial lighting and daylight, with more artificial lighting	No	N/A
82	Kack-March-063	March	A mix of daylight and artificial lighting, with more natural daylight	Yes	Yes
83	Kack-March-064	March	A mix of daylight and artificial lighting, with more natural daylight	Yes	Yes
84	Kack-March-065	March	A mix of daylight and artificial lighting, with more natural daylight	Yes	Yes
85	Kack-March-066	March	Only natural daylight	Yes	Yes
86	Kack-March-067	March	A mix of daylight and artificial lighting, with more natural daylight	Yes	Yes
87	Kack-March-068	March	Only natural daylight	Yes	Yes
88	Kack-March-069	March	A mix of daylight and artificial lighting, with more natural daylight	Yes	Yes
89	Kack-March-070	March	A mix of daylight and artificial lighting, with more natural daylight	Yes	Yes
90	Kack-March-071	March	A mix of daylight and artificial lighting, with more natural daylight	Yes	Yes
91	Kack-March-072	March	A mix of daylight and artificial lighting, with more natural daylight	Yes	Yes
92	Kack-March-073	March	A mix of artificial lighting and daylight, with more artificial lighting	No	N/A
93	Wit-June-020	June	Only natural daylight	No	N/A
94	Wit-June-021	June	Only natural daylight	Yes	No
95	Wit-June-022	June	Only natural daylight	Yes	Yes
96	Wit-June-023	June	Only natural daylight	Yes	Yes
97	Wit-June-024	June	Only natural daylight	No	N/A
98	Wit-June-025	June	A mix of daylight and artificial lighting, with more natural daylight	Yes	No
99	Wit-June-026	June	Only natural daylight	Yes	Yes
100	Wit-June-027	June	A mix of daylight and artificial lighting, with more natural daylight	No	No
101	Wit-June-028	June	A mix of daylight and artificial lighting, with more natural daylight	No	N/A
102	Wit-June-029	June	A mix of daylight and artificial lighting, with more natural daylight	Yes	Yes
103	Kack-June-074	June	A mix of daylight and artificial lighting, with more natural daylight	No	Yes
104	Kack-June-075	June	A mix of artificial lighting and daylight, with more artificial lighting	No	No

105	Kack-June-076	June	Only natural daylight	No	N/A
106	Kack-June-077	June	A mix of daylight and artificial lighting, with more natural daylight	No	Yes
107	Kack-June-078	June	Only artificial lighting	No	N/A
108	Kack-June-079	June	A mix of daylight and artificial lighting, with more natural daylight	Yes	Yes
109	Kack-June-080	June	A mix of artificial lighting and daylight, with more artificial lighting	Yes	No
110	Kack-June-081	June	A mix of daylight and artificial lighting, with more natural daylight	Yes	Yes
111	Kack-June-082	June	A mix of artificial lighting and daylight, with more artificial lighting	Yes	Yes
112	Kack-June-083	June	A mix of artificial lighting and daylight, with more artificial lighting	No	N/A
113	Kack-June-084	June	Only natural daylight	Yes	Yes
114	Kack-June-085	June	A mix of daylight and artificial lighting, with more natural daylight	No	N/A
115	Kack-June-086	June	A mix of daylight and artificial lighting, with more natural daylight	Yes	No
116	Kack-June-087	June	Only natural daylight	Yes	Yes
117	Kack-June-088	June	A mix of artificial lighting and daylight, with more artificial lighting	No	No
118	Kack-June-089	June	A mix of daylight and artificial lighting, with more natural daylight	No	Yes

APPENDIX 3 – User Questionnaire Responses (Questions 8-10)

No	User ID (Library, Month, Number)	Q8. Always sitting here	Q9. Duration of stay	Q9. How long have you been sitting here	Q10. A stimulating environment	Q10. A calm space for taking a break	Q10. An open, social setting for conversation
1	Kack-DEC-001	Yes	60	45 minutes or more	0	1	0
2	Kack-DEC-002	No	60	45 minutes or more	1	0	1
3	Kack-DEC-003	No	180	Three hours	0	1	0
4	Kack-DEC-004	No	60	45 minutes or more	1	0	0
5	Kack-DEC-005	No	60	45 minutes or more	0	1	0
6	Kack-DEC-006	No	60	45 minutes or more	0	1	0
7	Kack-DEC-007	No	30	Less than half an hour	0	1	0
8	Kack-DEC-008	Yes	180	Three hours	0	1	0
9	Kack-DEC-009	No	60	45 minutes or more	0	0	0
10	Kack-DEC-010	No	180	Three hours	0	1	0
11	Kack-DEC-011	Yes	60	45 minutes or more	0	0	0
12	Kack-DEC-012	Yes	60	45 minutes or more	0	1	0
13	Kack-DEC-013	No	60	45 minutes or more	0	0	0
14	Kack-DEC-014	No	60	45 minutes or more	0	0	0
15	Kack-DEC-015	Yes	60	45 minutes or more	0	1	0
16	Kack-DEC-016	No	180	Three hours	0	1	0
17	Kack-DEC-017	No	30	Less than half an hour	0	0	1
18	Kack-DEC-018	No	60	45 minutes or more	0	0	1
19	Kack-DEC-019	Yes	60	45 minutes or more	0	1	0
20	Kack-DEC-020	No	180	Three hours	0	1	0
21	Kack-DEC-021	No	30	Less than half an hour	0	0	1
22	Kack-DEC-022	No	60	45 minutes or more	0	0	1
23	Kack-DEC-023	No	30	Less than half an hour	1	0	0
24	Kack-DEC-024	No	60	45 minutes or more	0	0	1
25	Kack-DEC-025	No	30	Less than half an hour	0	1	0
26	Kack-DEC-026	No	30	Less than half an hour	0	1	0
27	Kack-DEC-027	Yes	60	45 minutes or more	0	0	0
28	Kack-DEC-028	No	60	45 minutes or more	0	1	0
29	Kack-DEC-029	No	60	45 minutes or more	0	0	1
30	Wit-DEC-001	No	180	Three hours	1	0	0
31	Wit-DEC-002	Yes	60	45 minutes or more	0	1	0
32	Wit-DEC-003	No	30	Less than half an hour	0	0	1
33	Wit-DEC-004	No	60	45 minutes or more	0	0	1
34	Wit-DEC-005	No	60	45 minutes or more	0	1	0
35	Wit-JAN-006	No	60	45 minutes or more	0	1	0
36	Wit-JAN-007	No	30	Less than half an hour	0	1	0
37	Wit-DEC-008	No	60	45 minutes or more	0	1	0
38	Wit-DEC-009	No	60	45 minutes or more	0	1	0
39	Wit-March-010	No	60	45 minutes or more	0	0	0
40	Wit-March-011	No	180	Three hours	1	0	0
41	Wit-March-012	No	60	45 minutes or more	0	1	0
42	Wit-March-013	No	60	45 minutes or more	0	1	0
43	Wit-March-014	No	60	45 minutes or more	0	0	0
44	Wit-March-015	No	60	45 minutes or more	0	1	0
45	Wit-March-016	Yes	60	45 minutes or more	0	1	0
46	Wit-March-017	No	60	45 minutes or more	0	1	0
47	Wit-March-018	Yes	240	More than three hours	0	0	1

48	Wit-March-019	No	60	45 minutes or more	0	0	0
49	Kack-FEB-030	Yes	60	45 minutes or more	0	1	1
50	Kack-FEB-031	No	60	45 minutes or more	0	1	0
51	Kack-FEB-032	Yes	60	45 minutes or more	0	1	0
52	Kack-FEB-033	No	60	45 minutes or more	0	0	1
53	Kack-FEB-034	No	240	More than three hours	0	0	0
54	Kack-FEB-035	No	30	Less than half an hour	0	0	1
55	Kack-FEB-036	No	60	45 minutes or more	0	1	0
56	Kack-FEB-037	No	60	45 minutes or more	0	0	0
57	Kack-FEB-038	No	180	Three hours	0	0	0
58	Kack-FEB-039	No	30	Less than half an hour	0	1	0
59	Kack-FEB-040	No	30	Less than half an hour	0	1	0
60	Kack-FEB-041	No	30	Less than half an hour	0	0	0
61	Kack-FEB-042	No	30	Less than half an hour	0	1	0
62	Kack-FEB-043	No	60	45 minutes or more	1	0	0
63	Kack-FEB-044	No	60	45 minutes or more	0	0	1
64	Kack-FEB-045	Yes	30	Less than half an hour	0	1	0
65	Kack-FEB-046	Yes	240	More than three hours	0	0	0
66	Kack-FEB-047	No	60	45 minutes or more	0	0	1
67	Kack-FEB-048	No	60	45 minutes or more	0	0	1
68	Kack-March-049	Yes	180	Three hours	0	0	0
69	Kack-March-050	No	60	45 minutes or more	0	1	0
70	Kack-March-051	No	30	Less than half an hour	0	1	0
71	Kack-March-052	Yes	180	Three hours	1	0	0
72	Kack-March-053	Yes	180	Three hours	0	0	0
73	Kack-March-054	No	30	Less than half an hour	1	0	0
74	Kack-March-055	No	60	45 minutes or more	0	1	1
75	Kack-March-056	No	30	Less than half an hour	0	1	0
76	Kack-March-057	No	60	45 minutes or more	0	1	0
77	Kack-March-058	No	30	Less than half an hour	1	0	0
78	Kack-March-059	No	60	45 minutes or more	0	1	0
79	Kack-March-060	No	30	Less than half an hour	0	0	0
80	Kack-March-061	Yes	180	Three hours	0	1	0
81	Kack-March-062	No	60	45 minutes or more	0	0	0
82	Kack-March-063	No	30	Less than half an hour	0	0	1
83	Kack-March-064	No	30	Less than half an hour	1	0	0
84	Kack-March-065	No	60	45 minutes or more	0	0	1
85	Kack-March-066	Yes	240	More than three hours	1	0	0
86	Kack-March-067	N/A	60	45 minutes or more	0	1	1
87	Kack-March-068	No	60	45 minutes or more	0	1	0
88	Kack-March-069	Yes	180	Three hours	0	1	0
89	Kack-March-070	Yes	60	45 minutes or more	0	0	1
90	Kack-March-071	Yes	60	45 minutes or more	0	0	1
91	Kack-March-072	Yes	30	Less than half an hour	0	0	1
92	Kack-March-073	Yes	180	Three hours	0	0	0
93	Wit-June-020	Yes	60	45 minutes or more	0	1	0
94	Wit-June-021	Yes	60	45 minutes or more	0	1	1
95	Wit-June-022	Yes	60	45 minutes or more	1	0	0
96	Wit-June-023	No	60	45 minutes or more	0	1	0
97	Wit-June-024	No	60	45 minutes or more	0	1	0
98	Wit-June-025	No	60	45 minutes or more	0	1	0
99	Wit-June-026	No	240	More than three hours	0	1	0
100	Wit-June-027	No	30	Less than half an hour	1	1	0
101	Wit-June-028	No	30	Less than half an hour	0	1	0

102	Wit-June-029	No	60	45 minutes or more	1	1	0
103	Kack-June-074	No	30	Less than half an hour	0	1	1
104	Kack-June-075	Yes	180	Three hours	0	1	0
105	Kack-June-076	No	60	45 minutes or more	0	0	0
106	Kack-June-077	Yes	60	45 minutes or more	0	1	0
107	Kack-June-078	Yes	60	45 minutes or more	0	1	0
108	Kack-June-079	Yes	240	More than three hours	0	0	0
109	Kack-June-080	Yes	180	Three hours	0	0	0
110	Kack-June-081	No	60	45 minutes or more	1	0	0
111	Kack-June-082	Yes	60	45 minutes or more	0	1	1
112	Kack-June-083	No	180	Three hours	1	0	0
113	Kack-June-084	No	60	45 minutes or more	0	0	1
114	Kack-June-085	Yes	60	45 minutes or more	0	1	0
115	Kack-June-086	No	60	45 minutes or more	0	0	0
116	Kack-June-087	No	60	45 minutes or more	0	0	0
117	Kack-June-088	No	60	45 minutes or more	0	1	0
118	Kack-June-089	No	30	Less than half an hour	1	1	1

APPENDIX 3 – User Questionnaire Responses (Questions 10-11)

No	User ID (Library, Month, Number)	Q10. A quiet, focused area for intense study	Q11. This spot was visible from the entrance	Q11. This spot was close to the entrance	Q11. This spot offered a clear view of the area around	Q11. This spot was near a main pathway
1	Kack-DEC-001	1	Strongly agree	Neutral	Strongly agree	Agree
2	Kack-DEC-002	0	Strongly agree	Agree	Agree	Agree
3	Kack-DEC-003	1	Strongly disagree	Strongly disagree	Disagree	Disagree
4	Kack-DEC-004	0	Agree	Agree	Agree	Neutral
5	Kack-DEC-005	1	Strongly disagree	Strongly disagree	Disagree	Neutral
6	Kack-DEC-006	0	Strongly agree	Neutral	Strongly agree	Neutral
7	Kack-DEC-007	0	Strongly agree	Neutral	Agree	Agree
8	Kack-DEC-008	1	Disagree	Disagree	Neutral	Agree
9	Kack-DEC-009	1	Strongly disagree	Strongly disagree	Neutral	Agree
10	Kack-DEC-010	1	Strongly disagree	Strongly disagree	Disagree	Disagree
11	Kack-DEC-011	1	Strongly disagree	Disagree	Strongly agree	Strongly agree
12	Kack-DEC-012	0	Disagree	Disagree	Neutral	Neutral
13	Kack-DEC-013	1	Strongly disagree	Strongly disagree	Strongly disagree	Strongly disagree
14	Kack-DEC-014	1	Neutral	Neutral	Neutral	Neutral
15	Kack-DEC-015	0	Neutral	Agree	Strongly agree	Agree
16	Kack-DEC-016	0	Strongly agree	Strongly agree	Strongly agree	Strongly agree
17	Kack-DEC-017	0	Strongly agree	Neutral	Neutral	Agree
18	Kack-DEC-018	0	Strongly disagree	Disagree	Agree	Neutral
19	Kack-DEC-019	0	Disagree	Disagree	Neutral	Disagree
20	Kack-DEC-020	1	Strongly disagree	Disagree	Strongly disagree	Strongly disagree
21	Kack-DEC-021	0	Neutral	Agree	Strongly agree	Strongly agree
22	Kack-DEC-022	0	Agree	Strongly disagree	Agree	Agree
23	Kack-DEC-023	0	Neutral	Strongly agree	Disagree	Neutral
24	Kack-DEC-024	0	Neutral	Neutral	Neutral	Neutral
25	Kack-DEC-025	0	Strongly disagree	Strongly disagree	Strongly agree	Strongly agree
26	Kack-DEC-026	0	Strongly agree	Strongly agree	Strongly agree	Strongly agree
27	Kack-DEC-027	1	Agree	Disagree	Strongly agree	Strongly agree
28	Kack-DEC-028	1	Strongly disagree	Strongly disagree	Strongly disagree	Strongly disagree
29	Kack-DEC-029	0	Strongly disagree	Strongly disagree	Neutral	Strongly agree
30	Wit-DEC-001	1	Agree	Agree	Strongly agree	Strongly agree
31	Wit-DEC-002	0	Strongly agree	Strongly disagree	Neutral	Strongly agree
32	Wit-DEC-003	0	Disagree	Neutral	Neutral	Agree
33	Wit-DEC-004	0	Strongly disagree	Disagree	Strongly agree	Agree
34	Wit-DEC-005	0	Strongly disagree	Neutral	Strongly agree	Strongly agree
35	Wit-JAN-006	1	Disagree	Strongly disagree	Agree	Neutral
36	Wit-JAN-007	0	Agree	Agree	Disagree	Strongly agree
37	Wit-DEC-008	0	Disagree	Neutral	Agree	Agree
38	Wit-DEC-009	1	Strongly disagree	Strongly disagree	Disagree	Strongly disagree
39	Wit-March-010	1	Strongly agree	Strongly agree	Strongly agree	Neutral
40	Wit-March-011	0	Strongly agree	Strongly agree	Disagree	Strongly agree
41	Wit-March-012	0	Neutral	Neutral	Neutral	Agree
42	Wit-March-013	0	Strongly agree	Strongly agree	Strongly agree	Strongly agree
43	Wit-March-014	1	Strongly disagree	Strongly disagree	Disagree	Disagree
44	Wit-March-015	1	Strongly disagree	Strongly disagree	Strongly disagree	Strongly disagree
45	Wit-March-016	0	Strongly agree	Strongly agree	Agree	Strongly agree
46	Wit-March-017	0	Neutral	Agree	Strongly agree	Strongly agree
47	Wit-March-018	0	Strongly agree	Strongly agree	Strongly agree	Strongly agree

48	Wit-March-019	1	Strongly agree	Strongly agree	Neutral	Strongly agree
49	Kack-FEB-030	0	Agree	Agree	Strongly agree	Neutral
50	Kack-FEB-031	0	Neutral	Neutral	Neutral	Neutral
51	Kack-FEB-032	0	Agree	Disagree	Agree	Neutral
52	Kack-FEB-033	0	Strongly agree	Strongly agree	Strongly agree	Strongly agree
53	Kack-FEB-034	1	Strongly disagree	Strongly agree	Strongly agree	Strongly agree
54	Kack-FEB-035	0	Neutral	Neutral	Neutral	Neutral
55	Kack-FEB-036	0	Neutral	Neutral	Agree	Agree
56	Kack-FEB-037	1	Strongly disagree	Strongly disagree	Strongly disagree	Strongly disagree
57	Kack-FEB-038	1	Neutral	Strongly disagree	Strongly disagree	Disagree
58	Kack-FEB-039	0	Strongly disagree	Disagree	Agree	Strongly agree
59	Kack-FEB-040	0	Strongly disagree	Strongly disagree	Agree	Strongly agree
60	Kack-FEB-041	1	Agree	Disagree	Strongly agree	Disagree
61	Kack-FEB-042	0	Strongly disagree	Strongly disagree	Strongly disagree	Strongly disagree
62	Kack-FEB-043	0	Strongly agree	Strongly disagree	Agree	Neutral
63	Kack-FEB-044	0	Neutral	Agree	Strongly agree	Strongly agree
64	Kack-FEB-045	0	Strongly agree	Disagree	Strongly disagree	Agree
65	Kack-FEB-046	1	Neutral	Strongly disagree	Neutral	Strongly disagree
66	Kack-FEB-047	0	Neutral	Neutral	Neutral	Neutral
67	Kack-FEB-048	0	Neutral	Agree	Neutral	Neutral
68	Kack-March-049	1	Agree	Neutral	Neutral	Neutral
69	Kack-March-050	0	Disagree	Disagree	Strongly disagree	Strongly disagree
70	Kack-March-051	0	Strongly agree	Strongly agree	Strongly agree	Strongly agree
71	Kack-March-052	1	Strongly disagree	Strongly disagree	Agree	Disagree
72	Kack-March-053	1	Disagree	Strongly disagree	Disagree	Disagree
73	Kack-March-054	0	Strongly agree	Strongly agree	Agree	Agree
74	Kack-March-055	1	Strongly disagree	Strongly disagree	Strongly agree	Agree
75	Kack-March-056	0	Disagree	Disagree	Strongly agree	Disagree
76	Kack-March-057	0	Agree	Agree	Agree	Agree
77	Kack-March-058	0	Neutral	Neutral	Neutral	Agree
78	Kack-March-059	0	Disagree	Neutral	Strongly agree	Strongly agree
79	Kack-March-060	1	Disagree	Disagree	Agree	Agree
80	Kack-March-061	1	Strongly disagree	Strongly disagree	Strongly disagree	Strongly disagree
81	Kack-March-062	1	Strongly disagree	Strongly disagree	Strongly disagree	Strongly disagree
82	Kack-March-063	0	Agree	Agree	Agree	Agree
83	Kack-March-064	0	Strongly disagree	Strongly disagree	Strongly agree	Neutral
84	Kack-March-065	0	Agree	Agree	Agree	Agree
85	Kack-March-066	0	Disagree	Disagree	Agree	Neutral
86	Kack-March-067	1	Strongly agree	Strongly agree	Neutral	Agree
87	Kack-March-068	0	Neutral	Neutral	Neutral	Neutral
88	Kack-March-069	0	Strongly disagree	Strongly disagree	Strongly agree	Strongly agree
89	Kack-March-070	0	Agree	Agree	Neutral	Neutral
90	Kack-March-071	0	Strongly agree	Strongly agree	Agree	Agree
91	Kack-March-072	0	Strongly disagree	Strongly disagree	Neutral	Neutral
92	Kack-March-073	1	Agree	Neutral	Neutral	Neutral
93	Wit-June-020	0	Strongly disagree	Agree	Neutral	Agree
94	Wit-June-021	0	Strongly agree	Strongly agree	Neutral	Strongly agree
95	Wit-June-022	0	Strongly disagree	Strongly disagree	Neutral	Strongly agree
96	Wit-June-023	0	Neutral	Neutral	Agree	Agree
97	Wit-June-024	1	Strongly disagree	Strongly disagree	Disagree	Strongly disagree
98	Wit-June-025	1	Agree	Neutral	Neutral	Neutral
99	Wit-June-026	0	Disagree	Disagree	Strongly agree	Strongly agree
100	Wit-June-027	1	Agree	Agree	Neutral	Disagree
101	Wit-June-028	0	Strongly disagree	Strongly disagree	Disagree	Neutral

102	Wit-June-029	0	Agree	Neutral	Strongly agree	Agree
103	Kack-June-074	0	Strongly agree	Strongly agree	Strongly agree	Strongly agree
104	Kack-June-075	0	Strongly disagree	Strongly disagree	Disagree	Strongly disagree
105	Kack-June-076	1	Neutral	Strongly disagree	Strongly disagree	Strongly disagree
106	Kack-June-077	0	Disagree	Disagree	Neutral	Neutral
107	Kack-June-078	0	Strongly disagree	Strongly disagree	Agree	Neutral
108	Kack-June-079	1	Disagree	Neutral	Neutral	Agree
109	Kack-June-080	1	Strongly disagree	Strongly disagree	Strongly agree	Strongly agree
110	Kack-June-081	0	Strongly disagree	Disagree	Agree	Agree
111	Kack-June-082	0	Neutral	Strongly agree	Agree	Agree
112	Kack-June-083	0	Disagree	Strongly agree	Strongly disagree	Strongly agree
113	Kack-June-084	0	Agree	Neutral	Strongly agree	Agree
114	Kack-June-085	0	Strongly disagree	Strongly disagree	Disagree	Disagree
115	Kack-June-086	1	Strongly disagree	Strongly disagree	Neutral	Neutral
116	Kack-June-087	1	Strongly disagree	Strongly disagree	Strongly agree	Neutral
117	Kack-June-088	1	Strongly disagree	Strongly disagree	Disagree	Disagree
118	Kack-June-089	1	Neutral	Neutral	Agree	Agree

APPENDIX 3 – User Questionnaire Responses (Question 11)

No	User ID (Library, Month, Number)	Q11. This spot made it easy to interact with others	Q11. This spot was close to natural light or a window	Q11. This spot felt spacious and open	Q11. This spot had a clear view from the window	Q11. It was an easy and direct path to this spot
1	Kack-DEC-001	Neutral	Strongly agree	Neutral	Strongly agree	Strongly agree
2	Kack-DEC-002	Agree	Strongly agree	Strongly agree	Neutral	Strongly agree
3	Kack-DEC-003	Disagree	Neutral	Neutral	Disagree	Disagree
4	Kack-DEC-004	Neutral	Neutral	Neutral	Neutral	Agree
5	Kack-DEC-005	Disagree	Strongly disagree	Strongly disagree	Strongly disagree	Strongly disagree
6	Kack-DEC-006	Agree	Strongly agree	Strongly agree	Agree	Strongly agree
7	Kack-DEC-007	Agree	Neutral	Agree	Neutral	Agree
8	Kack-DEC-008	Strongly disagree	Neutral	Disagree	Disagree	Disagree
9	Kack-DEC-009	Neutral	Disagree	Strongly agree	Strongly disagree	Strongly agree
10	Kack-DEC-010	Disagree	Neutral	Neutral	Disagree	Disagree
11	Kack-DEC-011	Agree	Strongly agree	Strongly agree	Agree	Strongly agree
12	Kack-DEC-012	Neutral	Agree	Agree	Neutral	Agree
13	Kack-DEC-013	Strongly disagree	Strongly disagree	Neutral	Strongly disagree	Agree
14	Kack-DEC-014	Neutral	Neutral	Neutral	Neutral	Neutral
15	Kack-DEC-015	Agree	Agree	Neutral	Strongly disagree	Neutral
16	Kack-DEC-016	Agree	Strongly agree	Strongly agree	Strongly agree	Strongly agree
17	Kack-DEC-017	Neutral	Strongly agree	Strongly agree	Strongly agree	Strongly agree
18	Kack-DEC-018	Agree	Agree	Agree	Disagree	Strongly agree
19	Kack-DEC-019	Strongly disagree	Strongly agree	Neutral	Disagree	Neutral
20	Kack-DEC-020	Strongly disagree	Strongly agree	Strongly agree	Strongly agree	Strongly agree
21	Kack-DEC-021	Strongly agree	Strongly agree	Strongly agree	Strongly agree	Strongly agree
22	Kack-DEC-022	Agree	Neutral	Agree	Neutral	Neutral
23	Kack-DEC-023	Agree	Strongly agree	Neutral	Strongly agree	Disagree
24	Kack-DEC-024	Neutral	Neutral	Neutral	Neutral	Neutral
25	Kack-DEC-025	Neutral	Strongly agree	Strongly agree	Strongly agree	Strongly agree
26	Kack-DEC-026	Agree	Strongly agree	Strongly agree	Strongly agree	Strongly agree
27	Kack-DEC-027	Agree	Agree	Agree	Disagree	Strongly agree
28	Kack-DEC-028	Strongly disagree	Strongly disagree	Strongly disagree	Strongly disagree	Neutral
29	Kack-DEC-029	Strongly disagree	Strongly disagree	Neutral	Strongly disagree	Strongly agree
30	Wit-DEC-001	Neutral	Disagree	Agree	Neutral	Strongly agree
31	Wit-DEC-002	Neutral	Strongly agree	Strongly agree	Strongly agree	Strongly agree
32	Wit-DEC-003	Agree	Agree	Agree	Neutral	Agree
33	Wit-DEC-004	Strongly agree	Strongly agree	Agree	Strongly agree	Strongly agree
34	Wit-DEC-005	Strongly agree	Strongly agree	Neutral	Strongly agree	Strongly agree
35	Wit-JAN-006	Disagree	Strongly agree	Strongly agree	Strongly agree	Agree
36	Wit-JAN-007	Neutral	Agree	Agree	Disagree	Strongly agree
37	Wit-DEC-008	Neutral	Strongly agree	Strongly agree	Strongly agree	Agree
38	Wit-DEC-009	Disagree	Agree	Agree	Strongly agree	Neutral
39	Wit-March-010	Agree	Agree	Strongly agree	Strongly agree	Strongly disagree
40	Wit-March-011	Strongly agree	Strongly agree	Strongly agree	Disagree	Strongly agree
41	Wit-March-012	Neutral	Neutral	Agree	Neutral	Agree
42	Wit-March-013	Strongly agree	Strongly agree	Strongly agree	Strongly agree	Strongly agree
43	Wit-March-014	Disagree	Strongly agree	Strongly agree	Agree	Neutral
44	Wit-March-015	Neutral	Strongly agree	Strongly agree	Strongly agree	Agree
45	Wit-March-016	Strongly disagree	Strongly disagree	Neutral	Strongly disagree	Strongly agree

46	Wit-March-017	Strongly agree	Strongly agree	Strongly agree	Strongly agree	Strongly agree
47	Wit-March-018	Strongly agree	Strongly agree	Strongly agree	Strongly agree	Strongly agree
48	Wit-March-019	Strongly disagree	Strongly agree	Strongly agree	Agree	Strongly agree
49	Kack-FEB-030	Agree	Neutral	Strongly agree	Agree	Strongly agree
50	Kack-FEB-031	Neutral	Neutral	Neutral	Neutral	Strongly agree
51	Kack-FEB-032	Neutral	Strongly agree	Agree	Strongly agree	Agree
52	Kack-FEB-033	Strongly agree	Agree	Agree	Neutral	Strongly agree
53	Kack-FEB-034	Neutral	Strongly disagree	Agree	Strongly disagree	Strongly agree
54	Kack-FEB-035	Neutral	Agree	Disagree	Neutral	Neutral
55	Kack-FEB-036	Agree	Neutral	Agree	Neutral	Agree
56	Kack-FEB-037	Strongly disagree	Strongly disagree	Strongly disagree	Strongly agree	Strongly agree
57	Kack-FEB-038	Disagree	Strongly disagree	Disagree	Strongly agree	Disagree
58	Kack-FEB-039	Disagree	Strongly agree	Agree	Strongly agree	Neutral
59	Kack-FEB-040	Agree	Agree	Strongly agree	Neutral	Neutral
60	Kack-FEB-041	Agree	Strongly agree	Agree	Strongly agree	Agree
61	Kack-FEB-042	Strongly disagree	Strongly disagree	Strongly disagree	Strongly disagree	Strongly disagree
62	Kack-FEB-043	Disagree	Strongly agree	Strongly agree	Strongly agree	Strongly agree
63	Kack-FEB-044	Strongly agree	Neutral	Strongly agree	Strongly disagree	Strongly agree
64	Kack-FEB-045	Agree	Strongly disagree	Strongly disagree	Strongly agree	Strongly agree
65	Kack-FEB-046	Strongly disagree	Agree	Agree	Agree	Neutral
66	Kack-FEB-047	Neutral	Neutral	Neutral	Neutral	Neutral
67	Kack-FEB-048	Agree	Neutral	Agree	Disagree	Neutral
68	Kack-March-049	Neutral	Disagree	Neutral	Strongly disagree	Neutral
69	Kack-March-050	Disagree	Neutral	Agree	Disagree	Strongly disagree
70	Kack-March-051	Strongly agree	Strongly agree	Strongly agree	Strongly agree	Strongly agree
71	Kack-March-052	Agree	Strongly agree	Strongly agree	Neutral	Strongly disagree
72	Kack-March-053	Disagree	Disagree	Disagree	Disagree	Disagree
73	Kack-March-054	Neutral	Agree	Strongly agree	Disagree	Strongly agree
74	Kack-March-055	Strongly disagree	Strongly agree	Strongly disagree	Strongly disagree	Strongly disagree
75	Kack-March-056	Neutral	Strongly agree	Strongly agree	Strongly agree	Strongly agree
76	Kack-March-057	Disagree	Disagree	Disagree	Neutral	Neutral
77	Kack-March-058	Agree	Neutral	Strongly agree	Neutral	Strongly agree
78	Kack-March-059	Neutral	Strongly agree	Strongly agree	Strongly agree	Strongly agree
79	Kack-March-060	Disagree	Agree	Agree	Neutral	Agree
80	Kack-March-061	Strongly disagree	Neutral	Strongly disagree	Strongly disagree	Neutral
81	Kack-March-062	Strongly disagree	Strongly disagree	Strongly disagree	Strongly disagree	Strongly disagree
82	Kack-March-063	Agree	Agree	Strongly agree	Agree	Agree
83	Kack-March-064	Agree	Strongly agree	Strongly agree	Strongly agree	Strongly agree
84	Kack-March-065	Agree	Agree	Agree	Agree	Agree
85	Kack-March-066	Neutral	Agree	Disagree	Agree	Neutral
86	Kack-March-067	Neutral	Strongly agree	Strongly agree	Strongly agree	Strongly agree
87	Kack-March-068	Neutral	Neutral	Neutral	Neutral	Neutral
88	Kack-March-069	Strongly agree	Strongly agree	Strongly agree	Strongly agree	Strongly agree
89	Kack-March-070	Neutral	Neutral	Neutral	Neutral	Neutral
90	Kack-March-071	Agree	Agree	Agree	Agree	Agree
91	Kack-March-072	Neutral	Strongly agree	Strongly agree	Strongly agree	Strongly agree
92	Kack-March-073	Neutral	Disagree	Neutral	Strongly disagree	Neutral
93	Wit-June-020	Strongly disagree	Neutral	Strongly disagree	Strongly disagree	Strongly disagree
94	Wit-June-021	Strongly agree	Strongly agree	Strongly agree	Neutral	Strongly agree
95	Wit-June-022	Strongly agree	Strongly agree	Agree	Strongly agree	Agree
96	Wit-June-023	Disagree	Strongly agree	Agree	Strongly agree	Disagree

97	Wit-June-024	Strongly disagree	Strongly agree	Agree	Agree	Agree
98	Wit-June-025	Disagree	Agree	Agree	Neutral	Agree
99	Wit-June-026	Strongly agree	Strongly agree	Strongly agree	Strongly agree	Strongly agree
100	Wit-June-027	Agree	Agree	Disagree	Strongly agree	Disagree
101	Wit-June-028	Disagree	Disagree	Neutral	Disagree	Agree
102	Wit-June-029	Neutral	Strongly agree	Strongly agree	Strongly agree	Strongly agree
103	Kack-June-074	Strongly agree	Strongly agree	Strongly agree	Strongly agree	Strongly agree
104	Kack-June-075	Neutral	Disagree	Strongly disagree	Strongly disagree	Neutral
105	Kack-June-076	Strongly disagree	Strongly disagree	Neutral	Strongly disagree	Agree
106	Kack-June-077	Neutral	Agree	Neutral	Disagree	Strongly agree
107	Kack-June-078	Neutral	Strongly disagree	Agree	Strongly disagree	Neutral
108	Kack-June-079	Disagree	Neutral	Agree	Disagree	Strongly agree
109	Kack-June-080	Strongly disagree	Strongly disagree	Strongly agree	Strongly disagree	Strongly agree
110	Kack-June-081	Disagree	Agree	Agree	Agree	Neutral
111	Kack-June-082	Strongly agree	Neutral	Agree	Neutral	Agree
112	Kack-June-083	Strongly agree	Disagree	Strongly disagree	Disagree	Agree
113	Kack-June-084	Strongly agree	Strongly agree	Strongly agree	Strongly agree	Strongly agree
114	Kack-June-085	Neutral	Disagree	Neutral	Strongly disagree	Neutral
115	Kack-June-086	Disagree	Strongly agree	Disagree	Agree	Agree
116	Kack-June-087	Neutral	Strongly agree	Strongly agree	Strongly agree	Disagree
117	Kack-June-088	Disagree	Disagree	Neutral	Disagree	Neutral
118	Kack-June-089	Neutral	Strongly agree	Strongly agree	Strongly agree	Strongly agree

APPENDIX 3 – User Questionnaire Responses (Questions 11-13)

No	User ID (Library, Month, Number)	Q11. This spot was quieter and had less foot traffic	Q12. Daylight is important	Q12. I prefer to sit near windows or daylight	Q13. Better focus in natural light	Q13. Dim lighting makes seating more appealing
1	Kack-DEC-001	Strongly disagree	Irrelevant	Irrelevant	Strongly disagree	Strongly disagree
2	Kack-DEC-002	Strongly disagree	Highly important	Highly important	Agree	Disagree
3	Kack-DEC-003	Agree	Important	Highly important	Agree	Agree
4	Kack-DEC-004	Strongly disagree	Highly important	Highly important	Agree	Neutral
5	Kack-DEC-005	Strongly agree	Important	Important	Agree	Strongly agree
6	Kack-DEC-006	Disagree	Highly important	Important	Strongly agree	Neutral
7	Kack-DEC-007	Disagree	Highly important	Highly important	Strongly agree	Agree
8	Kack-DEC-008	Strongly agree	Not important	Neutral	Agree	Disagree
9	Kack-DEC-009	Strongly agree	Highly important	Important	Neutral	Disagree
10	Kack-DEC-010	Agree	Important	Important	Agree	Agree
11	Kack-DEC-011	Neutral	Neutral	Neutral	Neutral	Agree
12	Kack-DEC-012	Strongly agree	Important	Important	Neutral	Neutral
13	Kack-DEC-013	Agree	Highly important	Highly important	Strongly agree	Disagree
14	Kack-DEC-014	Strongly agree	Neutral	Neutral	Neutral	Disagree
15	Kack-DEC-015	Disagree	Highly important	Highly important	Strongly agree	Neutral
16	Kack-DEC-016	Strongly agree	Highly important	Highly important	Strongly agree	Strongly agree
17	Kack-DEC-017	Strongly disagree	Highly important	Highly important	Strongly agree	Agree
18	Kack-DEC-018	Neutral	Highly important	Highly important	Strongly agree	Agree
19	Kack-DEC-019	Neutral	Important	Highly important	Neutral	Neutral
20	Kack-DEC-020	Strongly agree	Highly important	Irrelevant	Strongly agree	Strongly disagree
21	Kack-DEC-021	Strongly agree	Highly important	Highly important	Strongly agree	Neutral
22	Kack-DEC-022	Disagree	Highly important	Highly important	Strongly agree	Disagree
23	Kack-DEC-023	Strongly agree	Irrelevant	Irrelevant	Disagree	Neutral
24	Kack-DEC-024	Neutral	N/A	N/A	N/A	N/A
25	Kack-DEC-025	Strongly agree	Highly important	Highly important	Neutral	Strongly disagree
26	Kack-DEC-026	Disagree	N/A	N/A	N/A	N/A
27	Kack-DEC-027	Strongly agree	Highly important	Highly important	Strongly agree	Disagree
28	Kack-DEC-028	Agree	Neutral	Neutral	N/A	N/A
29	Kack-DEC-029	Strongly disagree	Highly important	Highly important	Neutral	Strongly agree
30	Wit-DEC-001	Disagree	Important	Neutral	Neutral	Neutral
31	Wit-DEC-002	Agree	Neutral	Neutral	Agree	Disagree
32	Wit-DEC-003	Neutral	Highly important	Highly important	Strongly agree	Agree
33	Wit-DEC-004	Neutral	Highly important	Highly important	Agree	Strongly agree
34	Wit-DEC-005	Strongly agree	Highly important	Highly important	Strongly agree	Strongly disagree
35	Wit-JAN-006	Agree	Important	Important	Agree	Neutral
36	Wit-JAN-007	Disagree	Highly important	Highly important	Strongly agree	Strongly disagree
37	Wit-DEC-008	Neutral	Highly important	Highly important	Strongly agree	Disagree
38	Wit-DEC-009	Strongly agree	Important	Important	Agree	Disagree
39	Wit-March-010	Strongly disagree	Important	Important	Agree	Strongly disagree
40	Wit-March-011	Strongly agree	Highly important	Highly important	Strongly agree	Strongly agree
41	Wit-March-012	Agree	Neutral	Neutral	Neutral	Neutral
42	Wit-March-013	Neutral	Highly important	Highly important	Strongly agree	Neutral
43	Wit-March-014	Strongly agree	Important	Highly important	Agree	Disagree
44	Wit-March-015	Agree	Highly important	Important	Strongly agree	Agree
45	Wit-March-016	Strongly disagree	Neutral	Not important	Neutral	Agree
46	Wit-March-017	Neutral	Highly important	Highly important	Agree	Disagree
47	Wit-March-018	Strongly agree	Highly important	Highly important	Strongly agree	Strongly agree

48	Wit-March-019	Neutral	Highly important	Highly important	Strongly agree	Disagree
49	Kack-FEB-030	Agree	Important	Highly important	Strongly agree	Disagree
50	Kack-FEB-031	Agree	Highly important	Irrelevant	Disagree	Disagree
51	Kack-FEB-032	Neutral	Important	Important	Agree	Agree
52	Kack-FEB-033	Disagree	Highly important	Highly important	Strongly agree	Disagree
53	Kack-FEB-034	Neutral	Highly important	Important	Strongly agree	Strongly agree
54	Kack-FEB-035	Strongly disagree	Irrelevant	Irrelevant	Neutral	Neutral
55	Kack-FEB-036	Neutral	Important	Important	Agree	Neutral
56	Kack-FEB-037	Strongly agree	Irrelevant	Irrelevant	Neutral	Strongly disagree
57	Kack-FEB-038	Strongly agree	Irrelevant	Irrelevant	Neutral	Strongly disagree
58	Kack-FEB-039	Neutral	Important	Important	Neutral	Agree
59	Kack-FEB-040	Neutral	Important	Neutral	Neutral	Disagree
60	Kack-FEB-041	Neutral	Highly important	Highly important	Strongly agree	Strongly agree
61	Kack-FEB-042	Strongly agree	Important	Neutral	Neutral	Neutral
62	Kack-FEB-043	Neutral	Important	Highly important	Strongly agree	Agree
63	Kack-FEB-044	Disagree	Important	Highly important	Disagree	Strongly agree
64	Kack-FEB-045	Strongly agree	Not important	Not important	Strongly disagree	Neutral
65	Kack-FEB-046	Strongly agree	Important	Neutral	Neutral	Neutral
66	Kack-FEB-047	Neutral	Irrelevant	Irrelevant	Neutral	Neutral
67	Kack-FEB-048	Disagree	Irrelevant	Irrelevant	Disagree	Neutral
68	Kack-March-049	Agree	Neutral	Neutral	Neutral	Neutral
69	Kack-March-050	Strongly agree	Highly important	Important	Strongly agree	Neutral
70	Kack-March-051	Strongly agree	Highly important	Highly important	Strongly agree	Neutral
71	Kack-March-052	Strongly agree	Important	Highly important	Agree	Disagree
72	Kack-March-053	Strongly agree	Important	Neutral	Agree	Disagree
73	Kack-March-054	Strongly disagree	Important	Important	Neutral	Neutral
74	Kack-March-055	Strongly agree	Highly important	Highly important	Strongly agree	Strongly disagree
75	Kack-March-056	Disagree	Important	Important	Agree	Disagree
76	Kack-March-057	Agree	Highly important	Important	Strongly agree	Strongly agree
77	Kack-March-058	Disagree	Highly important	Highly important	Strongly agree	Neutral
78	Kack-March-059	Agree	Highly important	Important	Strongly agree	Agree
79	Kack-March-060	Strongly agree	Highly important	Highly important	Neutral	Agree
80	Kack-March-061	Strongly agree	Neutral	Not important	Neutral	Agree
81	Kack-March-062	Strongly agree	Irrelevant	Irrelevant	Strongly disagree	Neutral
82	Kack-March-063	Agree	Highly important	Neutral	Neutral	Neutral
83	Kack-March-064	Neutral	Highly important	Highly important	Strongly agree	Neutral
84	Kack-March-065	Agree	Highly important	Highly important	Strongly agree	Agree
85	Kack-March-066	Strongly agree	Important	Important	Agree	Neutral
86	Kack-March-067	Strongly agree	Highly important	Neutral	Strongly agree	Neutral
87	Kack-March-068	Neutral	Important	Neutral	Disagree	Neutral
88	Kack-March-069	Disagree	Highly important	Highly important	Strongly agree	Neutral
89	Kack-March-070	Neutral	Highly important	Important	Strongly agree	Neutral
90	Kack-March-071	Agree	Highly important	Highly important	Agree	Neutral
91	Kack-March-072	Strongly agree	Highly important	Highly important	Strongly agree	Neutral
92	Kack-March-073	Agree	Neutral	Neutral	Disagree	Neutral
93	Wit-June-020	Agree	Highly important	Highly important	Strongly agree	Neutral
94	Wit-June-021	Strongly agree	Important	Highly important	Strongly agree	Agree
95	Wit-June-022	Disagree	Highly important	Highly important	Agree	Neutral
96	Wit-June-023	Strongly agree	Important	Important	Agree	Disagree
97	Wit-June-024	Strongly agree	Important	Neutral	Neutral	Agree
98	Wit-June-025	Strongly agree	Highly important	Important	Agree	Neutral
99	Wit-June-026	Strongly agree	Highly important	Highly important	Strongly agree	Neutral
100	Wit-June-027	Strongly disagree	Not important	Irrelevant	Disagree	Agree

101	Wit-June-028	Agree	Highly important	Highly important	Strongly agree	Strongly agree
102	Wit-June-029	Disagree	Highly important	Highly important	Strongly agree	Disagree
103	Kack-June-074	Strongly disagree	Important	Irrelevant	Strongly agree	Strongly agree
104	Kack-June-075	Strongly agree	Important	Highly important	Agree	Strongly agree
105	Kack-June-076	Strongly agree	Highly important	Highly important	Strongly agree	Neutral
106	Kack-June-077	Strongly agree	Important	Not important	Neutral	Agree
107	Kack-June-078	Strongly agree	Neutral	Irrelevant	Neutral	Agree
108	Kack-June-079	Agree	Highly important	Highly important	Strongly agree	Neutral
109	Kack-June-080	Strongly agree	Neutral	Neutral	Neutral	Disagree
110	Kack-June-081	Agree	Highly important	Highly important	Strongly agree	Disagree
111	Kack-June-082	Strongly agree	Important	Neutral	Neutral	Neutral
112	Kack-June-083	Agree	Important	Neutral	Agree	Neutral
113	Kack-June-084	Disagree	Highly important	Highly important	Strongly agree	Disagree
114	Kack-June-085	Strongly agree	Important	Neutral	Agree	Agree
115	Kack-June-086	Agree	Highly important	Highly important	Strongly agree	Disagree
116	Kack-June-087	Disagree	Highly important	Highly important	Strongly agree	Disagree
117	Kack-June-088	Strongly agree	Neutral	Not important	Disagree	Strongly agree
118	Kack-June-089	Neutral	Neutral	Highly important	Agree	Agree

APPENDIX 3 – User Questionnaire Responses (Questions 13-15)

No	User ID (Library, Month, Number)	Q13. Window views influence my seating choice	Q13. Window views distract me	Q14. How often do you visit the library	Q15. I study or read in the library	Q15. I borrow books for personal or academic use
1	Kack-DEC-001	Strongly agree	Disagree	Weekly	1	1
2	Kack-DEC-002	Strongly agree	Disagree	Weekly	0	1
3	Kack-DEC-003	Agree	Disagree	Monthly	1	0
4	Kack-DEC-004	Agree	Neutral	Daily	0	1
5	Kack-DEC-005	Strongly agree	Neutral	Daily	1	0
6	Kack-DEC-006	Agree	Neutral	Monthly	0	1
7	Kack-DEC-007	Agree	Agree	Monthly	1	0
8	Kack-DEC-008	Neutral	Strongly disagree	Weekly	1	0
9	Kack-DEC-009	Neutral	Agree	Rarely	0	0
10	Kack-DEC-010	Agree	Disagree	Monthly	1	0
11	Kack-DEC-011	Disagree	Neutral	Rarely	1	0
12	Kack-DEC-012	Disagree	Disagree	Weekly	1	0
13	Kack-DEC-013	Agree	Disagree	Weekly	1	1
14	Kack-DEC-014	Agree	Disagree	Weekly	0	0
15	Kack-DEC-015	Agree	Disagree	Daily	1	1
16	Kack-DEC-016	Strongly agree	Strongly agree	Daily	0	0
17	Kack-DEC-017	Strongly agree	Strongly disagree	Weekly	0	1
18	Kack-DEC-018	Strongly agree	Strongly disagree	Weekly	0	1
19	Kack-DEC-019	Agree	Disagree	Daily	1	1
20	Kack-DEC-020	Strongly agree	Strongly agree	Weekly	1	0
21	Kack-DEC-021	Strongly agree	Disagree	Weekly	0	0
22	Kack-DEC-022	Agree	Neutral	Monthly	0	1
23	Kack-DEC-023	Neutral	Neutral	Monthly	0	1
24	Kack-DEC-024	N/A	N/A	N/A	0	1
25	Kack-DEC-025	Disagree	Neutral	Rarely	0	1
26	Kack-DEC-026	N/A	N/A	N/A	0	1
27	Kack-DEC-027	Strongly agree	Agree	Weekly	1	0
28	Kack-DEC-028	N/A	N/A	N/A	1	1
29	Kack-DEC-029	Strongly agree	Strongly disagree	Weekly	1	1
30	Wit-DEC-001	Agree	Disagree	Weekly	1	0
31	Wit-DEC-002	Agree	Disagree	Weekly	1	0
32	Wit-DEC-003	Strongly disagree	Agree	Monthly	0	0
33	Wit-DEC-004	Strongly agree	Neutral	Rarely	0	1
34	Wit-DEC-005	Strongly agree	Strongly disagree	Rarely	1	1
35	Wit-JAN-006	Neutral	Disagree	Rarely	1	0
36	Wit-JAN-007	Agree	Strongly disagree	Rarely	0	1
37	Wit-DEC-008	Agree	Disagree	Monthly	1	0
38	Wit-DEC-009	Disagree	Disagree	Rarely	1	0
39	Wit-March-010	Neutral	Agree	Rarely	0	0
40	Wit-March-011	Strongly agree	Strongly agree	Weekly	0	1
41	Wit-March-012	Neutral	Agree	Monthly	1	0

42	Wit-March-013	Strongly agree	Neutral	Daily	0	1
43	Wit-March-014	Strongly agree	Disagree	Rarely	1	0
44	Wit-March-015	Disagree	Disagree	Weekly	1	0
45	Wit-March-016	Strongly disagree	Strongly disagree	Daily	0	0
46	Wit-March-017	Strongly agree	Neutral	Daily	0	1
47	Wit-March-018	Strongly agree	Strongly agree	Daily	1	0
48	Wit-March-019	Strongly agree	Disagree	Monthly	1	0
49	Kack-FEB-030	Agree	Disagree	Weekly	1	0
50	Kack-FEB-031	Strongly disagree	Neutral	Weekly	1	1
51	Kack-FEB-032	Agree	Neutral	Rarely	0	0
52	Kack-FEB-033	Strongly agree	Strongly disagree	Weekly	1	1
53	Kack-FEB-034	Agree	Disagree	Weekly	1	1
54	Kack-FEB-035	Neutral	Neutral	Weekly	0	1
55	Kack-FEB-036	Agree	Disagree	Monthly	0	1
56	Kack-FEB-037	Disagree	Strongly disagree	Weekly	1	1
57	Kack-FEB-038	Strongly agree	Strongly agree	Weekly	1	1
58	Kack-FEB-039	Strongly disagree	Strongly disagree	Weekly	0	1
59	Kack-FEB-040	Neutral	Strongly disagree	Weekly	0	1
60	Kack-FEB-041	Neutral	Agree	Weekly	1	1
61	Kack-FEB-042	Strongly agree	Neutral	Weekly	0	1
62	Kack-FEB-043	Strongly agree	Neutral	Weekly	1	1
63	Kack-FEB-044	Strongly agree	Agree	Rarely	1	1
64	Kack-FEB-045	Disagree	Strongly agree	Monthly	0	1
65	Kack-FEB-046	Neutral	Neutral	Rarely	0	0
66	Kack-FEB-047	Neutral	Neutral	Weekly	0	1
67	Kack-FEB-048	Agree	Strongly disagree	Monthly	0	0
68	Kack-March-049	Neutral	Neutral	Rarely	1	0
69	Kack-March-050	Agree	Agree	Weekly	0	1
70	Kack-March-051	Agree	Agree	Monthly	1	1
71	Kack-March-052	Neutral	Agree	Weekly	1	1
72	Kack-March-053	Neutral	Strongly disagree	Weekly	1	1
73	Kack-March-054	Agree	Neutral	Weekly	0	1
74	Kack-March-055	Strongly agree	Strongly disagree	Monthly	1	1
75	Kack-March-056	Agree	Strongly disagree	Monthly	0	1
76	Kack-March-057	Agree	Neutral	Monthly	0	1
77	Kack-March-058	Agree	Neutral	Weekly	0	1
78	Kack-March-059	Strongly agree	Disagree	Weekly	0	1
79	Kack-March-060	Neutral	Neutral	Monthly	1	1
80	Kack-March-061	Disagree	Disagree	Weekly	1	1
81	Kack-March-062	Strongly disagree	Strongly disagree	Weekly	1	0
82	Kack-March-063	Disagree	Agree	Weekly	1	1
83	Kack-March-064	Strongly agree	Strongly disagree	Weekly	0	1
84	Kack-March-065	Agree	Neutral	Rarely	0	1
85	Kack-March-066	Neutral	Neutral	Weekly	1	0
86	Kack-March-067	Neutral	Neutral	Weekly	1	0
87	Kack-March-068	Neutral	Neutral	Monthly	1	0
88	Kack-March-069	Strongly agree	Strongly disagree	Weekly	1	1

89	Kack-March-070	Agree	Neutral	Monthly	0	1
90	Kack-March-071	Strongly agree	Neutral	Rarely	0	1
91	Kack-March-072	Neutral	Strongly disagree	Monthly	0	1
92	Kack-March-073	Neutral	Neutral	Rarely	1	0
93	Wit-June-020	Agree	Strongly disagree	Monthly	1	1
94	Wit-June-021	Agree	Disagree	Weekly	1	1
95	Wit-June-022	Strongly agree	Neutral	Weekly	1	1
96	Wit-June-023	Agree	Disagree	Weekly	1	0
97	Wit-June-024	Neutral	Neutral	Weekly	1	1
98	Wit-June-025	Neutral	Agree	Weekly	1	1
99	Wit-June-026	Neutral	Disagree	Weekly	0	0
100	Wit-June-027	Strongly disagree	Disagree	Weekly	1	1
101	Wit-June-028	Disagree	Neutral	Monthly	1	0
102	Wit-June-029	Strongly agree	Disagree	Weekly	1	1
103	Kack-June-074	Strongly disagree	Disagree	Rarely	0	0
104	Kack-June-075	Agree	Neutral	Daily	1	0
105	Kack-June-076	Strongly agree	Neutral	Rarely	1	0
106	Kack-June-077	Disagree	Disagree	Weekly	1	1
107	Kack-June-078	Strongly disagree	Agree	Weekly	1	1
108	Kack-June-079	Strongly agree	Neutral	Weekly	1	0
109	Kack-June-080	Strongly disagree	Strongly disagree	Weekly	1	0
110	Kack-June-081	Strongly agree	Strongly disagree	Monthly	0	1
111	Kack-June-082	Neutral	Disagree	Weekly	0	0
112	Kack-June-083	Neutral	Disagree	Weekly	0	0
113	Kack-June-084	Strongly agree	Disagree	Monthly	1	0
114	Kack-June-085	Agree	Agree	Monthly	1	1
115	Kack-June-086	Agree	Disagree	Rarely	1	0
116	Kack-June-087	Agree	Disagree	Monthly	1	0
117	Kack-June-088	Neutral	Strongly agree	Monthly	1	1
118	Kack-June-089	Agree	Disagree	Rarely	0	1

APPENDIX 3 – User Questionnaire Responses (Questions 15-18)

No	User ID (Library, Month, Number)	Q15. I attend library events or workshops	Q16. Personality trait	Q17. Preferred type of space	Q18. Grab-and-go type
1	Kack-DEC-001	1	Introversion	Daylit space with artificial lighting	1
2	Kack-DEC-002	1	In between	Daylit space with artificial lighting	0
3	Kack-DEC-003	0	In between	Naturally lit space with direct sunlight	0
4	Kack-DEC-004	1	In between	Naturally lit space with direct sunlight	1
5	Kack-DEC-005	0	In between	Daylit space with artificial lighting	0
6	Kack-DEC-006	1	In between	Naturally lit space with direct sunlight	0
7	Kack-DEC-007	0	Extraversion	Daylit space with artificial lighting	0
8	Kack-DEC-008	0	Introversion	Daylit space with artificial lighting	1
9	Kack-DEC-009	1	In between	Daylit space with artificial lighting	0
10	Kack-DEC-010	0	In between	Daylit space with artificial lighting	0
11	Kack-DEC-011	0	In between	Daylit space with artificial lighting	1
12	Kack-DEC-012	0	Introversion	Daylit space with artificial lighting	1
13	Kack-DEC-013	1	In between	Naturally lit space with direct sunlight	1
14	Kack-DEC-014	0	In between	Daylit space with artificial lighting	1
15	Kack-DEC-015	1	In between	Naturally lit space with direct sunlight	0
16	Kack-DEC-016	0	In between	Naturally lit space with direct sunlight	1
17	Kack-DEC-017	0	Introversion	Naturally lit space with direct sunlight	0
18	Kack-DEC-018	0	Extraversion	Naturally lit space with direct sunlight	0
19	Kack-DEC-019	0	N/A	Daylit space with artificial lighting	0
20	Kack-DEC-020	0	Introversion	Daylit space with artificial lighting	0
21	Kack-DEC-021	1	Extraversion	Naturally lit space with direct sunlight	1
22	Kack-DEC-022	0	In between	Daylit space with artificial lighting	0
23	Kack-DEC-023	1	Extraversion	Daylit space with artificial lighting	1
24	Kack-DEC-024	1	Introversion	Naturally lit space with direct sunlight	1
25	Kack-DEC-025	0	Extraversion	Naturally lit space with direct sunlight	0
26	Kack-DEC-026	1	N/A	Naturally lit space with direct sunlight	0
27	Kack-DEC-027	0	Extraversion	Naturally lit space with direct sunlight	0
28	Kack-DEC-028	0	Introversion	Daylit space with artificial lighting	1
29	Kack-DEC-029	0	Extraversion	Daylit space with artificial lighting	0
30	Wit-DEC-001	0	Introversion	Daylit space with artificial lighting	0
31	Wit-DEC-002	0	Introversion	Naturally lit space with direct sunlight	1
32	Wit-DEC-003	1	Extraversion	Naturally lit space with direct sunlight	0
33	Wit-DEC-004	0	In between	Naturally lit space with direct sunlight	1
34	Wit-DEC-005	0	Introversion	Naturally lit space with direct sunlight	1
35	Wit-JAN-006	0	In between	Daylit space with artificial lighting	1
36	Wit-JAN-007	0	In between	Naturally lit space with direct sunlight	0
37	Wit-DEC-008	0	In between	Naturally lit space with direct sunlight	0
38	Wit-DEC-009	0	Introversion	Daylit space with artificial lighting	0
39	Wit-March-010	1	Introversion	Daylit space with artificial lighting	1
40	Wit-March-011	1	In between	Daylit space with artificial lighting	1
41	Wit-March-012	0	Introversion	Artificially lit space without direct sunlight	1
42	Wit-March-013	0	Extraversion	Naturally lit space with direct sunlight	0
43	Wit-March-014	1	In between	Daylit space with artificial lighting	0

44	Wit-March-015	0 In between	Daylit space with artificial lighting	1
45	Wit-March-016	1 Introversion	Daylit space with artificial lighting	0
46	Wit-March-017	0 Extraversion	Naturally lit space with direct sunlight	1
47	Wit-March-018	1 In between	Daylit space with artificial lighting	1
48	Wit-March-019	0 Introversion	Naturally lit space with direct sunlight	0
49	Kack-FEB-030	1 Introversion	Daylit space with artificial lighting	0
50	Kack-FEB-031	0 Introversion	Daylit space with artificial lighting	1
51	Kack-FEB-032	1 Introversion	Daylit space with artificial lighting	1
52	Kack-FEB-033	1 In between	Naturally lit space with direct sunlight	0
53	Kack-FEB-034	0 In between	Daylit space with artificial lighting	0
54	Kack-FEB-035	0 Extraversion	Daylit space with artificial lighting	1
55	Kack-FEB-036	0 In between	Daylit space with artificial lighting	0
56	Kack-FEB-037	1 Introversion	Daylit space with artificial lighting	0
57	Kack-FEB-038	0 In between	Daylit space with artificial lighting	0
58	Kack-FEB-039	0 Extraversion	Naturally lit space with direct sunlight	1
59	Kack-FEB-040	1 In between	Naturally lit space with direct sunlight	1
60	Kack-FEB-041	0 Extraversion	Naturally lit space with direct sunlight	1
61	Kack-FEB-042	1 In between	Daylit space with artificial lighting	0
62	Kack-FEB-043	0 In between	Daylit space with artificial lighting	1
63	Kack-FEB-044	0 Extraversion	Daylit space with artificial lighting	1
64	Kack-FEB-045	0 Introversion	Naturally lit space with direct sunlight	0
65	Kack-FEB-046	1 Introversion	Daylit space with artificial lighting	0
66	Kack-FEB-047	0 In between	Daylit space with artificial lighting	0
67	Kack-FEB-048	1 In between	Daylit space with artificial lighting	0
68	Kack-March-049	0 Introversion	Daylit space with artificial lighting	0
69	Kack-March-050	0 In between	Naturally lit space with direct sunlight	0
70	Kack-March-051	0 Extraversion	Naturally lit space with direct sunlight	1
71	Kack-March-052	0 In between	Daylit space with artificial lighting	0
72	Kack-March-053	0 Introversion	Daylit space with artificial lighting	1
73	Kack-March-054	0 Introversion	Daylit space with artificial lighting	0
74	Kack-March-055	0 Introversion	Naturally lit space with direct sunlight	1
75	Kack-March-056	0 In between	Naturally lit space with direct sunlight	0
76	Kack-March-057	0 In between	Naturally lit space with direct sunlight	0
77	Kack-March-058	0 Introversion	Daylit space with artificial lighting	1
78	Kack-March-059	0 Introversion	Daylit space with artificial lighting	1
79	Kack-March-060	0 In between	Naturally lit space with direct sunlight	0
80	Kack-March-061	1 In between	Daylit space with artificial lighting	1
81	Kack-March-062	0 Introversion	Daylit space with artificial lighting	1
82	Kack-March-063	1 Extraversion	Daylit space with artificial lighting	0
83	Kack-March-064	0 In between	Naturally lit space with direct sunlight	0
84	Kack-March-065	0 Introversion	Naturally lit space with direct sunlight	1
85	Kack-March-066	0 In between	Daylit space with artificial lighting	1
86	Kack-March-067	0 In between	Daylit space with artificial lighting	0
87	Kack-March-068	0 In between	Daylit space with artificial lighting	0
88	Kack-March-069	1 Extraversion	Naturally lit space with direct sunlight	1
89	Kack-March-070	0 In between	Naturally lit space with direct sunlight	1
90	Kack-March-071	1 Extraversion	Naturally lit space with direct sunlight	0
91	Kack-March-072	1 Extraversion	Naturally lit space with direct sunlight	1
92	Kack-March-073	0 Introversion	Daylit space with artificial lighting	0
93	Wit-June-020	1 Introversion	Naturally lit space with direct sunlight	0

94	Wit-June-021	0	In between	Naturally lit space with direct sunlight	0
95	Wit-June-022	0	In between	Daylit space with artificial lighting	1
96	Wit-June-023	0	In between	Naturally lit space with direct sunlight	0
97	Wit-June-024	0	Introversion	Daylit space with artificial lighting	0
98	Wit-June-025	0	Introversion	Daylit space with artificial lighting	0
99	Wit-June-026	1	In between	Naturally lit space with direct sunlight	0
100	Wit-June-027	1	Extraversion	Daylit space with artificial lighting	1
101	Wit-June-028	0	Introversion	Daylit space with artificial lighting	0
102	Wit-June-029	0	In between	Naturally lit space with direct sunlight	0
103	Kack-June-074	1	Introversion	Daylit space with artificial lighting	1
104	Kack-June-075	0	In between	Daylit space with artificial lighting	0
105	Kack-June-076	0	Introversion	Naturally lit space with direct sunlight	1
106	Kack-June-077	0	In between	Daylit space with artificial lighting	0
107	Kack-June-078	0	In between	Artificially lit space without direct sunlight	0
108	Kack-June-079	0	Introversion	Daylit space with artificial lighting	0
109	Kack-June-080	0	Introversion	Daylit space with artificial lighting	0
110	Kack-June-081	0	In between	Naturally lit space with direct sunlight	0
111	Kack-June-082	1	In between	Daylit space with artificial lighting	0
112	Kack-June-083	1	Introversion	Daylit space with artificial lighting	1
113	Kack-June-084	1	In between	Naturally lit space with direct sunlight	0
114	Kack-June-085	1	Introversion	Daylit space with artificial lighting	1
115	Kack-June-086	0	In between	Naturally lit space with direct sunlight	0
116	Kack-June-087	0	Extraversion	Naturally lit space with direct sunlight	0
117	Kack-June-088	0	Introversion	Artificially lit space without direct sunlight	0
118	Kack-June-089	0	In between	Daylit space with artificial lighting	0

APPENDIX 3 – User Questionnaire Responses (Questions 18-19)

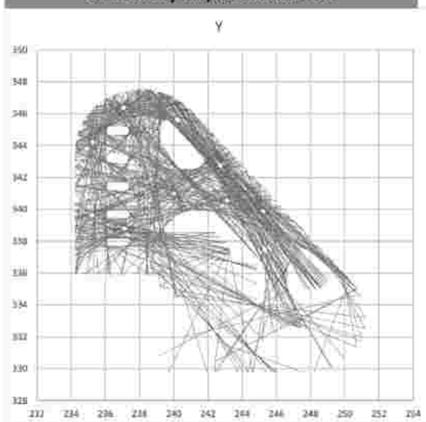
No	User ID (Library, Month, Number)	Q18. Oppurtunistic browsing type	Q18. Location seeding type	Q18. Satisficing type	Q18. Search seeding type	Q18. Wandering type	Q19. Is it important to notice others' movement in the library?
1	Kack-DEC-001	0	0	0	1	0	No effect
2	Kack-DEC-002	1	1	1	1	0	More likely to stay
3	Kack-DEC-003	0	0	0	1	0	No effect
4	Kack-DEC-004	0	1	0	0	0	No effect
5	Kack-DEC-005	0	1	0	0	1	No effect
6	Kack-DEC-006	1	0	1	0	1	No effect
7	Kack-DEC-007	1	0	1	1	0	Less likely to stay
8	Kack-DEC-008	0	0	0	0	0	Less likely to stay
9	Kack-DEC-009	1	0	0	0	0	No effect
10	Kack-DEC-010	0	0	0	1	0	No effect
11	Kack-DEC-011	1	1	1	1	0	No effect
12	Kack-DEC-012	1	0	0	0	0	No effect
13	Kack-DEC-013	1	1	0	0	0	No effect
14	Kack-DEC-014	1	1	1	1	1	No effect
15	Kack-DEC-015	1	0	1	1	0	Less likely to stay
16	Kack-DEC-016	0	0	0	0	0	More likely to stay
17	Kack-DEC-017	1	0	1	0	0	No effect
18	Kack-DEC-018	0	1	0	0	0	Less likely to stay
19	Kack-DEC-019	0	0	0	1	0	More likely to stay
20	Kack-DEC-020	1	1	0	1	0	No effect
21	Kack-DEC-021	1	1	1	0	0	No effect
22	Kack-DEC-022	0	1	0	0	0	No effect
23	Kack-DEC-023	1	0	0	1	0	No effect
24	Kack-DEC-024	0	1	0	0	0	More likely to stay
25	Kack-DEC-025	1	0	0	0	0	No effect
26	Kack-DEC-026	0	0	0	1	0	More likely to stay
27	Kack-DEC-027	0	0	0	1	0	No effect
28	Kack-DEC-028	0	0	0	0	0	Less likely to stay
29	Kack-DEC-029	1	0	0	1	1	No effect
30	Wit-DEC-001	0	1	0	1	0	Less likely to stay
31	Wit-DEC-002	0	0	0	0	0	No effect
32	Wit-DEC-003	0	1	1	0	1	More likely to stay
33	Wit-DEC-004	0	0	0	0	0	No effect
34	Wit-DEC-005	1	0	1	0	0	No effect
35	Wit-JAN-006	0	0	1	0	0	No effect
36	Wit-JAN-007	0	0	0	1	1	Less likely to stay
37	Wit-DEC-008	1	0	0	1	0	No effect
38	Wit-DEC-009	0	1	1	1	0	Less likely to stay
39	Wit-March-010	0	0	0	0	0	No effect
40	Wit-March-011	0	0	0	0	0	More likely to stay
41	Wit-March-012	0	1	0	1	0	No effect
42	Wit-March-013	1	0	0	0	0	More likely to stay
43	Wit-March-014	0	0	1	0	1	No effect
44	Wit-March-015	1	0	0	0	0	No effect

45	Wit-March-016	0	0	0	0	1	More likely to stay
46	Wit-March-017	0	1	0	0	0	No effect
47	Wit-March-018	0	0	0	0	0	More likely to stay
48	Wit-March-019	1	1	0	0	1	No effect
49	Kack-FEB-030	0	1	0	1	0	No effect
50	Kack-FEB-031	0	0	0	0	0	No effect
51	Kack-FEB-032	0	0	0	0	0	No effect
52	Kack-FEB-033	0	1	0	1	1	No effect
53	Kack-FEB-034	0	1	0	1	1	More likely to stay
54	Kack-FEB-035	0	0	0	0	0	No effect
55	Kack-FEB-036	1	0	0	0	0	No effect
56	Kack-FEB-037	0	0	1	1	0	No effect
57	Kack-FEB-038	1	0	0	1	0	No effect
58	Kack-FEB-039	0	0	0	0	0	No effect
59	Kack-FEB-040	1	1	0	0	0	More likely to stay
60	Kack-FEB-041	1	1	1	1	1	More likely to stay
61	Kack-FEB-042	1	0	0	0	0	Less likely to stay
62	Kack-FEB-043	0	1	0	0	0	More likely to stay
63	Kack-FEB-044	1	1	1	1	1	No effect
64	Kack-FEB-045	1	0	0	1	0	No effect
65	Kack-FEB-046	1	1	0	1	0	No effect
66	Kack-FEB-047	1	0	0	0	0	No effect
67	Kack-FEB-048	1	0	0	0	0	No effect
68	Kack-March-049	1	0	0	0	0	No effect
69	Kack-March-050	1	1	1	0	0	No effect
70	Kack-March-051	1	0	0	0	0	No effect
71	Kack-March-052	1	1	0	1	1	Less likely to stay
72	Kack-March-053	0	0	0	0	0	Less likely to stay
73	Kack-March-054	1	0	0	1	1	No effect
74	Kack-March-055	0	0	0	0	0	Less likely to stay
75	Kack-March-056	0	1	0	1	0	No effect
76	Kack-March-057	1	0	0	0	0	No effect
77	Kack-March-058	0	0	0	0	0	No effect
78	Kack-March-059	0	0	0	0	0	More likely to stay
79	Kack-March-060	0	1	0	0	0	No effect
80	Kack-March-061	1	0	0	1	0	Less likely to stay
81	Kack-March-062	0	0	0	0	0	Less likely to stay
82	Kack-March-063	0	1	1	0	0	No effect
83	Kack-March-064	1	1	0	1	0	Less likely to stay
84	Kack-March-065	0	1	0	0	0	Less likely to stay
85	Kack-March-066	0	0	0	0	0	No effect
86	Kack-March-067	1	1	0	1	0	No effect
87	Kack-March-068	1	1	0	0	0	No effect
88	Kack-March-069	1	0	1	0	0	No effect
89	Kack-March-070	0	0	0	0	0	No effect
90	Kack-March-071	1	1	0	0	0	No effect
91	Kack-March-072	0	0	1	0	0	No effect
92	Kack-March-073	1	0	0	0	0	No effect
93	Wit-June-020	1	0	0	0	0	No effect
94	Wit-June-021	0	0	0	1	0	More likely to stay
95	Wit-June-022	1	0	0	1	0	No effect

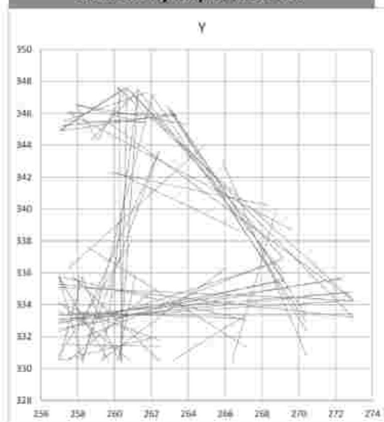
96	Wit-June-023	1	0	0	0	0	No effect
97	Wit-June-024	1	0	0	0	0	No effect
98	Wit-June-025	0	0	1	1	0	No effect
99	Wit-June-026	0	0	0	0	1	No effect
100	Wit-June-027	0	0	0	1	0	Less likely to stay
101	Wit-June-028	1	0	0	0	0	No effect
102	Wit-June-029	0	1	0	1	0	No effect
103	Kack-June-074	1	0	0	1	0	More likely to stay
104	Kack-June-075	1	0	0	1	1	No effect
105	Kack-June-076	0	0	0	0	0	Less likely to stay
106	Kack-June-077	1	0	0	0	0	More likely to stay
107	Kack-June-078	1	0	0	0	0	Less likely to stay
108	Kack-June-079	0	0	0	1	0	Less likely to stay
109	Kack-June-080	1	1	1	0	0	No effect
110	Kack-June-081	1	0	0	1	0	No effect
111	Kack-June-082	0	0	0	0	1	More likely to stay
112	Kack-June-083	0	0	0	0	0	No effect
113	Kack-June-084	1	1	0	0	0	Less likely to stay
114	Kack-June-085	1	1	0	1	0	No effect
115	Kack-June-086	1	0	1	0	0	Less likely to stay
116	Kack-June-087	1	0	0	1	0	More likely to stay
117	Kack-June-088	0	1	1	1	0	Less likely to stay
118	Kack-June-089	1	1	0	0	0	No effect

APPENDIX 4.1 – DepthmapX Analysis for Maly Kack

Connectivity Map of Ground Floor



Connectivity Map of First Floor



LineID Ground	X	Y	Connectivity	Line Length	Connectivity Value
0 Start	234.650768	345.416777	232	14.091467	very high
0 End	247.241086	339.088009			
1 Start	235.65952	346.649508	220	17.412142	very high
1 End	248.740455	335.157257			
2 Start	236.125184	346.980777	196	15.266207	very high
2 End	246.620014	335.894046			
3 Start	235.905839	346.841142	201	14.978922	very high
3 End	246.648667	336.402764			
4 Start	238.29556	347.512999	188	16.127026	very high
4 End	248.978725	335.431984			
5 Start	239.592554	347.215415	149	15.064841	high
5 End	248.978725	335.431984			
6 Start	240.237017	345.468263	126	13.359336	medium
6 End	248.864857	335.268643			
7 Start	240.211231	346.885262	131	14.485547	high
7 End	248.864857	335.268643			
8 Start	238.505582	347.503896	181	16.046051	high
8 End	248.591802	335.024157			
9 Start	238.203884	347.516973	184	16.24744	high
9 End	248.591802	335.024157			
10 Start	240.354133	345.543927	127	13.361316	medium
10 End	248.591802	335.024157			
11 Start	239.658355	347.187938	155	15.091854	high
11 End	248.591802	335.024157			
12 Start	242.105415	344.954928	101	11.861426	medium
12 End	248.591802	335.024157			
13 Start	239.893177	347.089883	155	14.777663	high
13 End	248.337649	334.962632			
14 Start	238.564659	347.501336	179	15.897497	high
14 End	248.337649	334.962632			
15 Start	239.090086	347.390997	173	15.491342	high
15 End	248.337649	334.962632			
16 Start	240.464706	346.72219	142	14.151693	high
16 End	248.337649	334.962632			

LineID 1st	X	Y	Connectivity	Line Length	Connectivity Value
0 Start	260.136946	342.288117	9	7.6818237	low
0 End	266.873979	338.597209			
1 Start	259.783417	342.288117	20	8.7828798	medium
1 End	268.3229	340.234779			
2 Start	256.969094	333.100502	41	16.049088	very high
2 End	272.975622	334.26851			
3 Start	260.175233	347.600834	33	18.482447	high
3 End	272.975622	334.26851			
4 Start	256.969094	335.093291	38	16.027763	very high
4 End	272.975622	334.26851			
5 Start	259.605182	345.489024	31	17.45476	high
5 End	272.975622	334.26851			
6 Start	256.969094	335.312392	37	16.139069	very high
6 End	272.969837	333.20389			
7 Start	260.672929	347.59688	33	18.930719	high
7 End	272.969837	333.20389			
8 Start	256.969094	333.326794	41	15.933355	very high
8 End	272.835643	334.784342			
9 Start	256.969094	332.9276	41	15.97482	very high
9 End	272.835643	334.784342			
10 Start	256.969094	332.487591	41	15.656498	very high
10 End	272.292491	335.699981			
11 Start	265.842376	343.068491	24	13.112491	medium
11 End	270.439094	330.788117			
12 Start	263.067585	346.238369	27	14.900631	high
12 End	270.439094	333.288865			
13 Start	262.83749	346.501225	28	16.052563	high
13 End	270.439094	332.362612			
14 Start	258.528886	332.062057	36	11.726432	very high
14 End	269.186387	336.953568			
15 Start	266.386852	330.488117	27	9.572506	high
15 End	268.730334	339.769333			
16 Start	261.28118	347.478506	24	13.995595	medium
16 End	269.186387	335.92929			

17 Start	238.368342	347.509845	180	16.025593	high
17 End	248.337649	334.962632			
18 Start	243.017139	343.913388	99	10.412678	medium
18 End	248.337649	334.962632			
19 Start	240.962968	346.260044	129	13.291044	high
19 End	247.96442	334.962632			
20 Start	242.263309	344.774553	110	11.307582	medium
20 End	247.883594	334.962632			
21 Start	244.089308	342.688557	81	8.5291061	medium
21 End	247.702577	334.962632			
22 Start	244.2753	329.766879	106	9.5888281	medium
22 End	247.493657	338.799476			
23 Start	242.494375	329.766879	107	10.149349	medium
23 End	247.858124	338.383113			
24 Start	244.889912	341.773958	111	9.4809971	medium
24 End	247.304194	332.605504			
25 Start	239.833473	334.636672	58	11.481053	low
25 End	251.225439	333.209199			
26 Start	247.378593	338.930924	32	6.8946619	low
26 End	251.225439	333.209199			
27 Start	239.168165	335.185648	60	12.275726	low
27 End	251.160825	332.564662			
28 Start	249.126252	336.934422	24	4.8201962	low
28 End	251.160825	332.564662			
29 Start	238.655282	347.487972	177	17.930531	high
29 End	250.994236	334.478201			
30 Start	240.284561	345.480729	130	15.354242	high
30 End	250.994236	334.478201			
31 Start	238.70533	336.085806	61	12.952615	low
31 End	250.977662	331.943329			
32 Start	249.599382	336.393924	22	4.6591258	low
32 End	250.977662	331.943329			
33 Start	238.60277	347.499684	180	17.357462	high
33 End	250.706459	335.058534			
34 Start	240.676368	344.477298	133	13.75921	high
34 End	250.706459	335.058534			
35 Start	240.20344	345.468812	129	14.788079	high
35 End	250.706459	335.058534			
36 Start	241.598885	342.739461	131	11.914047	high
36 End	250.706459	335.058534			
37 Start	246.901829	332.703432	34	4.4745626	low
37 End	250.706459	335.058534			
38 Start	236.464795	337.688149	78	15.559478	medium
38 End	250.68232	331.366808			
39 Start	249.861604	336.094366	23	4.7982683	low
39 End	250.68232	331.366808			
40 Start	238.046735	347.523784	191	17.125957	very high
40 End	250.315934	335.575345			
41 Start	241.767012	343.178167	132	11.440584	high
41 End	250.315934	335.575345			
42 Start	241.215631	342.551779	134	11.466741	high
42 End	250.315934	335.575345			
43 Start	248.194945	329.79978	25	6.1527028	low
43 End	250.315934	335.575345			
44 Start	240.594772	332.011948	57	10.641288	low

17 Start	262.83749	346.501225	19	12.673453	medium
17 End	269.186387	335.532728			
18 Start	262.03326	347.140278	28	16.575985	high
18 End	270.439094	332.853737			
19 Start	256.969094	333.384082	39	16.018629	very high
19 End	272.987722	333.39045			
20 Start	256.969094	333.036694	41	15.606738	very high
20 End	272.363644	335.601473			
21 Start	256.969094	332.841584	38	12.502286	very high
21 End	269.187353	335.49136			
22 Start	258.372349	332.709765	34	11.195689	high
22 End	269.186387	335.608046			
23 Start	263.149094	330.488117	4	4.8918786	low
23 End	267.119094	333.346364			
24 Start	258.469094	337.662385	28	10.698558	high
24 End	267.119094	331.36662			
25 Start	256.969094	333.541043	34	10.158025	high
25 End	267.119094	333.13736			
26 Start	256.969094	332.323127	40	13.004943	very high
26 End	269.186387	336.78029			
27 Start	257.492711	346.049967	30	14.310907	high
27 End	269.728921	338.628563			
28 Start	257.517427	336.288117	20	10.774694	medium
28 End	264.945329	344.093263			
29 Start	260.672929	347.59688	26	13.680595	high
29 End	269.186387	336.888018			
30 Start	259.230698	330.488117	27	9.0166111	high
30 End	266.083748	336.347723			
31 Start	258.208391	330.488117	36	13.796482	very high
31 End	262.416117	343.627293			
32 Start	258.184034	332.709765	31	11.709097	high
32 End	262.416117	343.627293			
33 Start	257.724762	335.788117	31	7.0999517	high
33 End	262.449094	330.488117			
34 Start	257.871365	346.540479	23	6.1240687	medium
34 End	263.872379	345.318984			
35 Start	257.033817	344.904392	24	6.3671727	medium
35 End	263.31326	345.957713			
36 Start	257.131031	345.231508	24	6.2916813	medium
36 End	263.390256	345.869754			
37 Start	258.303755	330.488117	46	17.059013	very high
37 End	262.04768	347.131222			
38 Start	258.675736	344.288117	19	4.119092	medium
38 End	261.28118	347.478506			
39 Start	259.361356	330.488117	48	17.098511	very high
39 End	261.28118	347.478506			
40 Start	260.300504	330.488117	47	17.018667	very high
40 End	261.28118	347.478506			
41 Start	257.486587	330.488117	31	6.529655	high
41 End	262.196586	335.010539			
42 Start	260.186129	330.488117	26	5.5278354	high
42 End	261.147394	335.931731			
43 Start	257.063005	345.002605	15	4.4454265	medium
43 End	260.672929	347.59688			
44 Start	259.07735	344.288117	17	3.673389	medium

44 End	250.898321	334.671625			
45 Start	242.369772	330.428173	55	9.5329952	low
45 End	250.740706	334.989472			
46 Start	239.475846	347.264149	171	19.753233	high
46 End	249.24317	330.094712			
47 Start	234.724666	345.535338	240	17.480259	very high
47 End	249.613925	336.377311			
48 Start	236.252993	342.938149	182	14.367274	high
48 End	249.243358	336.800642			
49 Start	240.576273	342.497074	135	11.351546	high
49 End	249.911	336.037936			
50 Start	244.198352	342.563986	119	10.522511	medium
50 End	247.473754	332.564237			
51 Start	240.521726	342.492407	105	15.203688	medium
51 End	250.019502	330.620407			
52 Start	241.967218	345.112803	143	13.92274	high
52 End	247.797504	332.469606			
53 Start	245.199726	331.756443	112	9.1795673	medium
53 End	245.632348	340.92581			
54 Start	245.327416	341.27416	115	9.1866121	medium
54 End	245.672909	332.094047			
55 Start	244.742937	341.94186	124	9.5378284	medium
55 End	246.28274	332.529146			
56 Start	239.893177	347.089883	160	13.354363	high
56 End	246.620014	335.553476			
57 Start	239.329728	347.325164	162	13.727709	high
57 End	246.620014	335.693238			
58 Start	240.280053	346.840986	151	13.02805	high
58 End	246.620014	335.459642			
59 Start	241.43612	345.719522	135	11.785221	high
59 End	246.638215	335.144568			
60 Start	241.232988	342.553264	98	8.3454294	medium
60 End	246.620014	336.1794			
61 Start	245.105937	336.745887	96	4.3668261	medium
61 End	245.483018	341.096402			
62 Start	240.962968	346.260044	116	13.557176	medium
62 End	248.732204	335.149869			
63 Start	240.25099	344.963255	135	14.999682	high
63 End	250.988539	334.489691			
64 Start	242.369772	329.766879	61	7.825655	low
64 End	246.634515	336.328345			
65 Start	244.619271	329.766879	115	10.59381	medium
65 End	246.235603	340.236659			
66 Start	244.566001	342.143989	126	10.006176	medium
66 End	245.85024	332.220568			
67 Start	234.397905	344.78598	228	13.862863	very high
67 End	247.104719	339.243793			
68 Start	234.242214	343.525512	215	13.21019	very high
68 End	246.839125	339.547204			
69 Start	236.293827	347.06966	191	16.069246	very high
69 End	246.728939	334.84963			
70 Start	237.199549	346.305779	168	14.98469	high
70 End	246.755453	334.763437			
71 Start	240.464706	346.72219	167	15.559057	high
71 End	247.108793	332.653061			

44 End	260.672929	347.59688			
45 Start	260.337158	330.488117	48	17.112059	very high
45 End	260.672929	347.59688			
46 Start	256.969094	335.788117	33	10.519392	high
46 End	267.119094	333.024946			
47 Start	260.238528	347.600331	47	17.112944	very high
47 End	260.396442	330.488117			
48 Start	256.969094	334.0997	31	5.9474792	high
48 End	262.449094	331.788399			
49 Start	256.969094	330.488117	18	5.6968527	medium
49 End	262.449094	332.04495			
50 Start	256.969094	331.511283	18	5.4812212	medium
50 End	262.449094	331.395577			
51 Start	256.969094	334.189969	31	5.3777957	high
51 End	260.869989	330.488117			
52 Start	258.1932	335.788117	28	5.6760712	high
52 End	260.224894	330.488117			
53 Start	257.492711	346.049967	23	5.8872199	medium
53 End	263.377597	345.884216			
54 Start	257.871365	346.540479	16	3.9938884	medium
54 End	261.687319	345.361647			
55 Start	256.969094	330.795036	30	7.9480658	high
55 End	260.818059	337.748971			
56 Start	256.969094	335.735508	28	5.9036007	high
56 End	259.674162	330.488117			
57 Start	257.033817	344.904392	12	4.4018688	low
57 End	260.515226	347.598133			
58 Start	257.210341	345.498379	18	4.8588648	medium
58 End	261.720998	347.30463			
59 Start	257.210341	345.498379	16	4.4809346	medium
59 End	261.691146	345.464165			
60 Start	257.871365	346.540479	12	2.5561736	low
60 End	259.080038	344.288117			
61 Start	256.969094	330.488117	23	5.4581804	medium
61 End	258.273598	335.788117			
62 Start	258.01058	330.488117	23	5.30018	medium
62 End	258.054251	335.788117			
63 Start	256.969094	335.788117	21	3.4456363	medium
63 End	258.517047	332.709765			
64 Start	256.969094	335.788117	23	5.4586563	medium
64 End	258.275589	330.488117			

72 Start	240.962968	346.260044	160	14.85047	high
72 End	246.981816	332.683965			
73 Start	241.997353	345.078377	150	13.222238	high
73 End	246.73	332.732138			
74 Start	240.117021	346.945873	162	15.979937	high
74 End	247.21278	332.627753			
75 Start	234.239772	339.915636	203	12.14917	very high
75 End	246.388054	340.062502			
76 Start	234.239772	340.338224	196	12.511801	very high
76 End	246.733595	339.66776			
77 Start	236.86237	344.688149	152	12.967041	high
77 End	246.620014	336.148095			
78 Start	236.00159	346.915637	201	15.282804	very high
78 End	246.620014	335.924132			
79 Start	241.443448	342.632531	95	8.8808737	medium
79 End	246.620014	335.416363			
80 Start	234.239772	341.482266	199	12.811889	very high
80 End	246.894803	339.483599			
81 Start	239.893177	347.089883	173	19.390696	high
81 End	249.201591	330.079518			
82 Start	240.464706	346.72219	165	15.932202	high
82 End	247.67438	332.514597			
83 Start	241.788733	345.316702	145	13.822632	high
83 End	247.250019	332.61869			
84 Start	234.239772	342.708782	211	13.332287	very high
84 End	247.111755	339.235755			
85 Start	234.239772	343.171746	209	13.587753	very high
85 End	247.210343	339.123129			
86 Start	245.013938	341.632272	105	4.9996243	medium
86 End	245.201966	336.636185			
87 Start	237.923816	347.529112	195	16.273127	very high
87 End	249.009592	335.616085			
88 Start	239.593386	347.215067	154	15.14622	high
88 End	248.640324	335.067602			
89 Start	239.119772	330.808368	49	8.6366367	low
89 End	246.6974	334.952164			
90 Start	234.239772	339.996579	132	15.092523	high
90 End	247.387279	332.585283			
91 Start	234.239772	342.714122	154	15.842038	high
91 End	246.493411	332.67328			
92 Start	235.356537	339.676616	118	13.73634	medium
92 End	247.154811	332.641861			
93 Start	236.402685	339.438149	97	12.46532	medium
93 End	246.893412	332.705481			
94 Start	234.239772	339.897322	132	15.119146	high
94 End	247.462969	332.566862			
95 Start	238.644459	336.31625	62	13.061181	low
95 End	250.888944	331.770149			
96 Start	234.239772	341.264348	132	16.421228	high
96 End	245.964317	329.766879			
97 Start	236.721168	339.438149	94	13.324656	medium
97 End	245.887026	329.766879			
98 Start	236.286002	341.188149	119	14.83929	medium
98 End	245.76013	329.766879			
99 Start	238.644459	336.31625	35	9.9161539	low
99 End	246.089986	329.766879			

100 Start	234.239772	337.939923	77	10.723977	medium
100 End	244.867064	336.503141			
101 Start	234.239772	339.53605	105	11.126447	medium
101 End	244.867064	336.24083			
102 Start	235.367589	339.591385	93	10.098562	medium
102 End	244.867064	336.16488			
103 Start	234.239772	338.944225	96	10.942179	medium
103 End	244.867064	336.338091			
104 Start	243.218431	337.533378	45	7.8908043	low
104 End	244.613527	329.766879			
105 Start	242.587195	344.40455	128	6.0859132	medium
105 End	243.647704	338.411749			
106 Start	241.727507	345.386646	128	7.913764	medium
106 End	244.139856	337.849522			
107 Start	239.893177	347.089883	170	16.35453	high
107 End	247.429177	332.575086			
108 Start	234.239772	339.698665	104	9.2360592	medium
108 End	243.218431	337.533378			
109 Start	234.239772	337.728651	83	8.9807825	medium
109 End	243.218431	337.533378			
110 Start	234.239772	339.173518	99	9.1272335	medium
110 End	243.218431	337.533378			
111 Start	234.239772	338.530568	93	9.033865	medium
111 End	243.218431	337.533378			
112 Start	238.644459	336.31625	46	4.7331405	low
112 End	243.218431	337.533378			
113 Start	238.751628	335.910531	46	4.7524695	low
113 End	243.218431	337.533378			
114 Start	239.168165	335.185648	46	4.6815052	low
114 End	243.218431	337.533378			
115 Start	240.189168	334.471447	44	4.3071866	low
115 End	243.218431	337.533378			
116 Start	239.672845	329.766879	44	8.5375452	low
116 End	243.218431	337.533378			
117 Start	242.369772	329.766879	46	7.8127284	low
117 End	243.218431	337.533378			
118 Start	234.239772	342.208574	212	12.22069	very high
118 End	246.289995	340.174523			
119 Start	234.239772	338.922917	208	11.62724	very high
119 End	245.707979	340.83941			
120 Start	234.239772	338.505448	206	11.63715	very high
120 End	245.619245	340.940778			
121 Start	234.239772	341.103044	201	11.704263	very high
121 End	245.932473	340.582951			
122 Start	234.239772	339.813325	206	11.707243	very high
122 End	245.920804	340.596282			
123 Start	234.239772	338.760303	206	11.409698	very high
123 End	245.383326	341.210289			
124 Start	234.239772	341.395398	203	12.241887	very high
124 End	246.406546	340.041376			
125 Start	234.239772	342.538458	188	11.152526	very high
125 End	245.083232	339.931124			
126 Start	234.239772	338.111301	209	11.490174	very high
126 End	245.26559	341.344789			
127 Start	234.244684	343.610657	215	14.071607	very high

127 End	247.475695	338.819995			
128 Start	234.650768	345.416777	241	17.105543	very high
128 End	249.35365	336.674646			
129 Start	234.461429	344.944449	233	16.039909	very high
129 End	248.654896	337.472892			
130 Start	234.239772	339.006462	91	8.8647785	medium
130 End	243.037027	337.914407			
131 Start	234.239772	337.566069	77	8.8041496	medium
131 End	243.037027	337.914407			
132 Start	234.239772	338.33585	86	8.8073454	medium
132 End	243.037027	337.914407			
133 Start	235.35654	339.67661	92	8.3710251	medium
133 End	243.329611	337.126279			
134 Start	234.239772	339.350539	100	9.3580189	medium
134 End	243.329611	337.126279			
135 Start	235.302084	339.491547	90	8.3687325	medium
135 End	243.329611	337.126279			
136 Start	234.239772	338.733186	93	9.2307816	medium
136 End	243.329611	337.126279			
137 Start	242.205337	344.840779	129	6.0859141	high
137 End	243.265846	338.847978			
138 Start	242.820277	344.13828	128	5.0177846	medium
138 End	243.023684	339.12462			
139 Start	240.464706	346.72219	140	11.939927	high
139 End	246.718586	336.551111			
140 Start	240.962968	346.260044	137	11.69948	high
140 End	246.620014	336.019162			
141 Start	239.266064	347.351748	137	9.39818	high
141 End	245.11417	339.99475			
142 Start	236.512378	338.188149	189	8.7128105	very high
142 End	243.630269	343.212957			
143 Start	237.923816	347.529112	192	15.838991	very high
143 End	249.404158	336.616946			
144 Start	237.537533	347.477507	186	13.187757	very high
144 End	247.48067	338.814312			
145 Start	234.239772	338.16888	86	8.5518017	medium
145 End	242.791116	338.257362			
146 Start	234.239772	338.849245	88	8.5718031	medium
146 End	242.791116	338.257362			
147 Start	234.239772	339.408278	197	10.225704	very high
147 End	243.811867	343.005501			
148 Start	235.367245	339.643303	182	9.0807276	high
148 End	243.794807	343.024991			
149 Start	234.239772	341.429992	190	9.8595324	very high
149 End	244.005913	342.783827			
150 Start	234.239772	340.380718	187	9.9817467	very high
150 End	243.895878	342.909529			
151 Start	234.239772	342.158893	193	9.8705873	very high
151 End	244.096581	342.680249			
152 Start	237.923816	347.529112	165	10.417378	high
152 End	245.149815	340.025333			
153 Start	239.266064	347.351748	167	13.092992	high
153 End	246.868732	336.692204			
154 Start	237.794525	347.51184	165	10.520854	high
154 End	245.207964	340.046635			

155 Start	239.893177	347.089883	158	12.865634	high
155 End	246.620014	336.122924			
156 Start	234.239772	338.082215	86	8.2620068	medium
156 End	242.488443	338.551436			
157 Start	234.239772	337.172885	78	8.3630724	medium
157 End	242.488443	338.551436			
158 Start	234.239772	338.513265	85	8.2487602	medium
158 End	242.488443	338.551436			
159 Start	234.239772	342.804383	211	15.177395	very high
159 End	248.510662	337.637663			
160 Start	236.808558	339.438149	91	12.303842	medium
160 End	244.414546	329.766879			
161 Start	236.489669	341.188149	117	13.726124	medium
161 End	244.102886	329.766879			
162 Start	236.646101	342.938149	141	14.977961	high
162 End	243.777506	329.766879			
163 Start	238.622354	336.582912	32	9.1193657	low
163 End	244.68078	329.766879			
164 Start	242.369772	331.75879	16	5.6198521	low
164 End	247.624772	329.766879			
165 Start	234.239772	341.578955	197	13.544683	very high
165 End	247.49571	338.79713			
166 Start	238.60277	347.499684	172	13.627312	high
166 End	246.720439	336.554042			
167 Start	238.687047	347.480887	166	13.597402	high
167 End	246.669157	336.472925			
168 Start	240.962968	346.260044	134	7.1268001	high
168 End	242.804313	339.375226			
169 Start	234.239772	339.36863	196	10.12024	very high
169 End	243.57546	343.275569			
170 Start	235.369042	339.607995	183	8.9806557	high
170 End	243.557413	343.296187			
171 Start	234.239772	340.202755	187	9.8648577	very high
171 End	243.636367	343.205991			
172 Start	234.239772	337.426321	213	10.989663	very high
172 End	243.457053	343.410836			
173 Start	235.498594	335.905937	205	10.947816	very high
173 End	243.329681	343.556344			
174 Start	237.061922	335.905937	199	9.9114246	very high
174 End	243.247323	343.650429			
175 Start	234.239772	336.650589	216	11.392907	very high
175 End	243.025197	343.904183			
176 Start	234.239772	337.063357	216	11.138175	very high
176 End	243.063787	343.860098			
177 Start	237.760377	335.905937	201	9.7682962	very high
177 End	242.597975	344.392235			
178 Start	234.239772	339.335263	195	10.046624	very high
178 End	243.386302	343.491662			
179 Start	235.361288	339.567129	183	8.9107313	high
179 End	243.328511	343.557681			
180 Start	234.239772	341.377368	157	8.4527769	high
180 End	242.577246	342.768754			
181 Start	234.650768	345.416777	154	6.368279	high
181 End	240.962968	346.260044			
182 Start	235.010243	345.99351	148	5.9586892	high
182 End	240.962968	346.260044			

183 Start	234.409508	344.814926	153	6.7109017	high
183 End	240.962968	346.260044			
184 Start	235.219795	346.226027	142	5.7432742	high
184 End	240.962968	346.260044			
185 Start	235.64567	346.638733	134	5.3307657	high
185 End	240.962968	346.260044			
186 Start	234.239772	343.235903	156	7.3720284	high
186 End	240.962968	346.260044			
187 Start	234.239772	337.494393	210	11.584958	very high
187 End	245.095884	341.538659			
188 Start	234.239772	337.628644	209	11.57406	very high
188 End	245.158982	341.466576			
189 Start	234.37873	344.693815	217	12.367744	very high
189 End	246.011201	340.493013			
190 Start	234.239772	343.12898	192	10.451028	very high
190 End	244.636356	342.063616			
191 Start	234.397905	344.78598	156	6.368279	high
191 End	240.464706	346.72219			
192 Start	234.650768	345.416777	151	5.9586892	high
192 End	240.464706	346.72219			
193 Start	234.239772	342.03631	166	7.7914867	high
193 End	240.464706	346.72219			
194 Start	234.353672	344.573373	155	6.4778194	high
194 End	240.464706	346.72219			
195 Start	235.418583	346.4466	130	5.0536427	high
195 End	240.464706	346.72219			
196 Start	234.973172	345.934034	141	5.5478044	high
196 End	240.464706	346.72219			
197 Start	234.239772	342.692101	163	7.4156199	high
197 End	240.464706	346.72219			
198 Start	240.313427	344.891926	65	1.8365052	low
198 End	240.464706	346.72219			
199 Start	234.660399	335.905937	195	11.659252	very high
199 End	244.34935	342.391489			
200 Start	239.266064	347.351748	172	13.42047	high
200 End	246.620014	336.12551			
201 Start	236.00159	346.915637	136	5.9587188	high
201 End	241.752993	345.35753			
202 Start	235.445761	346.476756	143	6.1886177	high
202 End	241.567505	345.56943			
203 Start	235.891701	346.830144	136	5.9884291	high
203 End	241.708813	345.408001			
204 Start	235.010243	345.99351	147	6.4366102	high
204 End	241.44079	345.714187			
205 Start	237.124135	346.24574	113	5.100266	medium
205 End	242.069039	344.996485			
206 Start	237.250209	347.439123	217	13.296544	very high
206 End	240.189168	334.471447			
207 Start	237.78707	347.510844	215	13.258806	very high
207 End	240.189168	334.471447			
208 Start	238.628132	336.513205	134	6.3391609	high
208 End	240.692024	342.506978			
209 Start	237.250209	347.439123	165	8.3007984	high
209 End	240.68381	339.881766			
210 Start	237.923816	347.529112	164	8.1285467	high

210	End	240.568678	339.842892			
211	Start	238.343037	347.510941	162	8.0021315	high
211	End	240.502159	339.805599			
212	Start	236.602791	347.2325	161	10.085894	high
212	End	242.854513	339.317879			
213	Start	236.435917	347.144549	164	8.4751186	high
213	End	240.851554	339.910616			
214	Start	236.756989	347.281712	164	8.4090681	high
214	End	240.782391	339.898721			
215	Start	236.102929	346.969047	164	8.5541534	high
215	End	240.937259	339.911938			
216	Start	235.766239	335.905937	208	10.826849	very high
216	End	242.888567	344.060267			
217	Start	234.877733	345.780914	157	8.8137035	high
217	End	241.453179	339.911938			
218	Start	234.754353	345.582967	157	8.8477964	high
218	End	241.545739	339.911938			
219	Start	234.239772	337.144992	212	11.192162	very high
219	End	243.682445	343.153351			
220	Start	234.239772	337.845816	205	10.919902	very high
220	End	243.942084	342.856743			
221	Start	234.249599	343.78009	220	16.206722	very high
221	End	249.003887	337.07421			
222	Start	234.239772	341.208104	198	11.251642	very high
222	End	245.490768	341.087548			
223	Start	234.239772	342.661177	210	14.305654	very high
223	End	247.882145	338.355673			
224	Start	234.239772	339.489936	196	10.51378	very high
224	End	244.343235	342.398475			
225	Start	234.254127	343.936159	136	8.4684849	high
225	End	241.70536	339.911938			
226	Start	234.239772	336.801857	216	11.316045	very high
226	End	243.253182	343.643736			
227	Start	236.663138	338.188149	194	8.5527048	very high
227	End	243.025444	343.903901			
228	Start	234.397905	344.78598	146	5.9586892	high
228	End	239.893177	347.089883			
229	Start	234.650768	345.416777	139	5.5029206	high
229	End	239.893177	347.089883			
230	Start	234.239772	341.644361	161	7.849503	high
230	End	239.893177	347.089883			
231	Start	234.292752	344.280565	147	6.2655425	high
231	End	239.893177	347.089883			
232	Start	235.167301	346.16778	118	4.8149943	medium
232	End	239.893177	347.089883			
233	Start	236.778506	339.938149	160	7.8005428	high
233	End	239.893177	347.089883			
234	Start	236.549039	341.688149	139	6.3531079	high
234	End	239.893177	347.089883			
235	Start	236.478069	347.166765	163	8.3893871	high
235	End	240.49405	339.801053			
236	Start	236.217894	347.02964	163	8.4000778	high
236	End	240.540011	339.826821			
237	Start	235.46521	346.498336	112	4.7641768	medium
237	End	240.124579	345.504528			

238 Start	236.602791	347.2325	142	7.3921843	high
238 End	243.137205	343.776227			
239 Start	236.023677	346.927277	142	6.7855196	high
239 End	242.403042	344.614924			
240 Start	237.250209	347.439123	165	9.8536549	high
240 End	245.120668	341.510345			
241 Start	239.266064	347.351748	69	2.90698	low
241 End	240.474542	344.707866			
242 Start	234.239772	339.45964	92	8.9352617	medium
242 End	243.039494	337.909227			
243 Start	236.469595	342.938149	142	15.947568	high
243 End	245.460845	329.766879			
244 Start	238.60277	347.499684	219	12.640345	very high
244 End	239.464732	334.888762			
245 Start	236.956954	347.345531	218	18.275715	very high
245 End	241.95623	329.766879			
246 Start	237.923816	347.529112	218	13.206241	very high
246 End	240.114966	334.505915			
247 Start	236.344533	341.688149	138	6.4904938	high
247 End	240.344939	346.799241			
248 Start	234.259479	344.120636	139	5.9586892	high
248 End	239.266064	347.351748			
249 Start	234.397905	344.78598	129	5.5029206	high
249 End	239.266064	347.351748			
250 Start	234.253783	343.92429	138	6.0721025	high
250 End	239.266064	347.351748			
251 Start	234.84491	345.728254	109	4.7098122	medium
251 End	239.266064	347.351748			
252 Start	236.964528	335.905937	211	11.674916	very high
252 End	239.266064	347.351748			
253 Start	236.772562	341.688149	132	6.1882071	high
253 End	239.266064	347.351748			
254 Start	236.410988	343.438149	112	4.8443484	medium
254 End	239.266064	347.351748			
255 Start	238.369392	335.905937	213	11.480881	very high
255 End	239.266064	347.351748			
256 Start	238.751628	335.910531	217	11.452777	very high
256 End	239.266064	347.351748			
257 Start	236.879982	335.905937	210	11.61527	very high
257 End	239.681389	347.17832			
258 Start	238.35983	335.905937	208	11.440963	very high
258 End	239.388687	347.300544			
259 Start	238.644459	336.31625	208	11.029021	very high
259 End	239.333115	347.32375			
260 Start	239.168165	335.185648	215	12.18361	very high
260 End	239.187626	347.369242			
261 Start	234.239772	338.39637	79	11.369855	medium
261 End	244.867064	334.354805			
262 Start	234.240666	343.472154	130	5.9370823	high
262 End	238.60277	347.499684			
263 Start	234.249264	343.768539	128	5.7336249	medium
263 End	238.60277	347.499684			
264 Start	236.972172	341.688149	126	6.0359569	medium
264 End	238.60277	347.499684			
265 Start	236.753869	343.438149	103	4.4625659	medium
265 End	238.60277	347.499684			

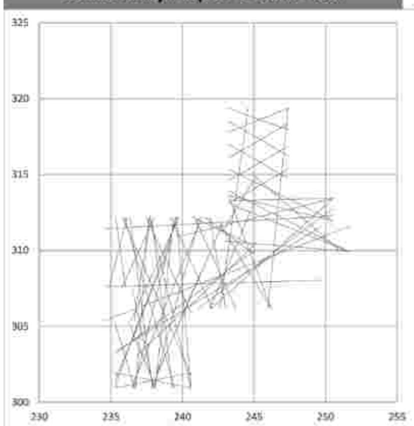
266 Start	238.419412	335.905937	210	11.595197	very high
266 End	238.60277	347.499684			
267 Start	237.250209	347.439123	201	11.602893	very high
267 End	238.520154	335.905937			
268 Start	237.923816	347.529112	206	11.635983	very high
268 End	238.469632	335.905937			
269 Start	234.242603	343.538929	115	5.428894	medium
269 End	237.923816	347.529112			
270 Start	237.159282	341.688149	119	5.8907857	medium
270 End	237.923816	347.529112			
271 Start	237.058497	343.438149	95	4.1814771	medium
271 End	237.923816	347.529112			
272 Start	234.650768	345.416777	99	4.5627918	medium
272 End	239.19695	345.027805			
273 Start	235.010243	345.99351	98	4.4188409	medium
273 End	239.183287	344.540285			
274 Start	235.46521	346.498336	102	5.2178698	medium
274 End	239.729254	343.490997			
275 Start	236.00159	346.915637	167	8.8175116	high
275 End	241.358522	339.911938			
276 Start	236.602791	347.2325	166	8.7594652	high
276 End	239.51298	338.970598			
277 Start	234.278382	344.211495	97	4.9771657	medium
277 End	239.195648	344.98135			
278 Start	234.248609	343.745952	99	5.1870685	medium
278 End	239.207991	345.265887			
279 Start	234.239772	341.531432	154	7.8628416	high
279 End	239.733686	347.156482			
280 Start	234.259479	344.120636	103	5.9899349	medium
280 End	240.106077	342.818095			
281 Start	234.397905	344.78598	202	11.766426	very high
281 End	245.08435	339.861686			
282 Start	234.938901	345.87905	154	8.3599911	high
282 End	240.780182	339.898341			
283 Start	234.239772	339.038213	61	5.336576	low
283 End	238.560407	335.905937			
284 Start	234.239772	339.781432	115	7.0876141	medium
284 End	239.192019	344.851887			
285 Start	234.380235	344.70105	133	7.7040267	high
285 End	239.763182	339.189616			
286 Start	234.239772	339.147127	119	6.9311447	medium
286 End	240.019256	342.973133			
287 Start	234.239772	338.596648	133	7.3104825	high
287 End	239.835945	343.300476			
288 Start	234.239772	338.031432	140	7.7745137	high
288 End	239.671969	343.593292			
289 Start	234.239772	343.094867	152	15.782061	high
289 End	245.266991	331.804435			
290 Start	234.239772	336.281432	147	8.7599707	high
290 End	240.360526	342.548285			
291 Start	236.58381	338.188149	132	6.1705618	high
291 End	239.724374	343.499711			
292 Start	234.239772	341.537204	122	6.6253591	medium
292 End	237.250209	347.439123			
293 Start	234.239772	340.304431	113	11.720842	medium

293 End	244.867064	335.36087			
294 Start	234.239772	337.36801	207	11.440894	very high
294 End	244.710256	341.979195			
295 Start	234.259479	344.120636	128	5.6191764	medium
295 End	238.778363	347.460521			
296 Start	234.239772	343.427281	123	5.8567672	medium
296 End	238.442214	347.506643			
297 Start	236.00159	346.915637	106	4.4051476	medium
297 End	240.165889	345.478993			
298 Start	235.010243	345.99351	141	5.5760574	high
298 End	240.548133	346.644809			
299 Start	235.46521	346.498336	130	5.1099234	high
299 End	240.573657	346.621136			
300 Start	235.010243	345.99351	112	4.7485099	medium
300 End	239.599634	347.212458			
301 Start	234.239772	340.39505	134	14.628433	high
301 End	246.700389	332.731888			
302 Start	234.397905	344.78598	102	4.9076595	medium
302 End	238.483596	347.504849			
303 Start	234.650768	345.416777	105	4.7337637	medium
303 End	238.937418	347.425047			
304 Start	234.259479	344.120636	110	5.1582942	medium
304 End	238.139416	347.519767			
305 Start	234.239772	343.21682	111	5.5925169	medium
305 End	237.817806	347.51495			
306 Start	234.239772	342.370953	118	6.1350846	medium
306 End	237.622925	347.488915			
307 Start	234.239772	341.170783	123	6.5060182	medium
307 End	236.602791	347.2325			
308 Start	234.239772	337.585344	168	9.9323454	high
308 End	236.602791	347.2325			
309 Start	234.239772	335.905937	177	11.497808	high
309 End	236.501478	347.179103			
310 Start	234.259479	344.120636	143	6.1692615	high
310 End	239.597554	347.213327			
311 Start	234.884037	335.905937	181	11.29089	high
311 End	236.353021	347.100859			
312 Start	234.397905	344.78598	101	4.7977667	medium
312 End	239.187785	344.511003			
313 Start	235.010243	345.99351	71	3.3313451	low
313 End	237.147529	343.438149			
314 Start	235.46521	346.498336	71	3.2440364	low
314 End	236.541791	343.438149			
315 Start	234.259479	344.120636	137	7.8028369	high
315 End	240.826322	339.906276			
316 Start	234.397905	344.78598	75	4.2140927	medium
316 End	237.254831	341.688149			
317 Start	235.010243	345.99351	90	4.571981	medium
317 End	236.54871	341.688149			
318 Start	234.468709	344.962609	76	4.2072945	medium
318 End	237.110534	341.688149			
319 Start	234.734691	345.551421	81	4.3601456	medium
319 End	236.756078	341.688149			
320 Start	234.239772	335.905937	109	7.3879337	medium
320 End	236.504623	342.938149			

321 Start	234.239772	338.014254	89	5.5203409	medium
321 End	236.735652	342.938149			
322 Start	234.259479	344.120636	82	4.9395757	medium
322 End	236.887446	339.938149			
323 Start	234.650768	345.416777	103	5.7923036	medium
323 End	236.531039	339.938149			
324 Start	235.015723	345.999591	116	6.2140131	medium
324 End	236.38426	339.938149			
325 Start	234.239772	335.905937	87	5.8183589	medium
325 End	236.679347	341.188149			
326 Start	234.239772	339.581208	198	10.959585	very high
326 End	245.003424	341.644283			
327 Start	234.239772	338.896081	133	7.3947182	high
327 End	240.69289	342.507052			
328 Start	234.259479	344.120636	119	6.3752637	medium
328 End	236.593913	338.188149			
329 Start	234.239772	339.497635	87	5.6713328	medium
329 End	239.908213	339.31657			
330 Start	234.239772	341.097772	77	5.9157586	medium
330 End	237.075446	335.905937			
331 Start	234.87654	345.779	155	9.9856758	high
331 End	236.371985	335.905937			
332 Start	235.205736	346.210428	166	10.361323	high
332 End	236.289476	335.905937			
333 Start	235.46521	346.498336	172	10.620035	high
333 End	236.230862	335.905937			
334 Start	236.00159	346.915637	178	11.010352	high
334 End	236.121438	335.905937			
335 Start	234.239772	335.905937	170	11.149776	high
335 End	236.00159	346.915637			
336 Start	235.048604	335.905937	178	11.050868	high
336 End	236.00159	346.915637			
337 Start	234.239772	338.752273	141	8.3513184	high
337 End	236.00159	346.915637			
338 Start	234.239772	338.540078	132	8.0520544	high
338 End	235.46521	346.498336			
339 Start	235.318317	335.905937	170	10.593418	high
339 End	235.46521	346.498336			
340 Start	235.016341	346.000276	162	10.109797	high
340 End	235.575188	335.905937			
341 Start	234.259479	344.120636	100	5.2915173	medium
341 End	239.542684	343.82416			
342 Start	234.239772	335.905937	153	10.51214	high
342 End	235.340771	346.360261			

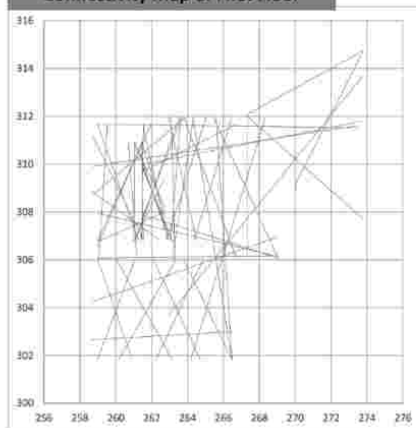
APPENDIX 4.2 – DepthmapX Analysis for Witomino

Connectivity Map of Ground Floor



LineID Gdound	X	Y	Connectivity	Line Length	Connectivity Value
0 Start	242.979	310.608	15	8.6747398	medium
0 End	251.629	309.953			
1 Start	234.479	305.354	37	18.243105	very high
1 End	251.629	311.574			
2 Start	243.229	313.926	16	9.3044796	medium
2 End	251.629	309.924			
3 Start	243.229	313.108	15	8.9829912	medium
3 End	251.629	309.924			
4 Start	245.12	314.854	15	7.7322149	medium
4 End	251.077	309.924			
5 Start	235.279	303.317	38	16.591019	very high
5 End	249.669	311.574			
6 Start	241.098	306.174	19	11.485393	medium
6 End	250.509	312.758			
7 Start	239.666	310.896	23	11.134062	high
7 End	250.509	313.424			
8 Start	242.02	306.174	20	11.163953	medium
8 End	250.509	313.424			
9 Start	243.229	313.299	12	7.2810822	medium
9 End	250.509	313.424			
10 Start	243.229	315.358	12	8.0277853	medium
10 End	250.509	311.974			
11 Start	243.229	313.627	13	7.465167	medium
11 End	250.509	311.974			
12 Start	243.229	317.802	4	4.445354	low
12 End	247.389	319.369			
13 Start	245.977	306.174	23	13.27035	high
13 End	247.389	319.369			
14 Start	243.229	319.369	4	4.4023438	low
14 End	247.389	317.929			

Connectivity Map of First Floor



Line ID 1st	X	Y	Connectivity	Line Length	Connectivity value
0 Start	267.332	312.072	2	6.9881201	low
0 End	273.792	314.737			
1 Start	270.018	309.137	6	6.7530804	low
1 End	273.792	314.737			
2 Start	267.332	311.992	7	7.7297621	low
2 End	273.772	307.717			
3 Start	261.457	309.98	27	12.468726	very high
3 End	273.792	311.802			
4 Start	262.931	303.648	18	14.802094	high
4 End	273.792	313.705			
5 Start	261.457	307.882	26	7.8028364	very high
5 End	269.047	306.072			
6 Start	265.434	311.972	13	6.9186506	medium
6 End	269.047	306.072			
7 Start	267.332	306.072	12	6	medium
7 End	267.332	312.072			
8 Start	258.982	311.672	26	14.510808	very high
8 End	273.492	311.519			
9 Start	258.682	309.898	34	14.908597	very high
9 End	273.492	311.61			
10 Start	264.181	301.807	17	11.012915	high
10 End	268.37	311.992			
11 Start	261.457	309.684	23	5.6557703	high
11 End	266.752	311.672			
12 Start	263.756	306.022	7	5.0254178	low
12 End	266.492	301.807			
13 Start	264.293	311.972	17	10.400237	high
13 End	266.492	301.807			
14 Start	265.593	311.972	16	10.204699	medium
14 End	266.492	301.807			

15 Start	243.229	316.101	5	4.7368126	low
15 End	247.389	318.366			
16 Start	243.229	318.508	5	4.7368126	low
16 End	247.389	316.243			
17 Start	243.229	314.601	5	4.7368126	low
17 End	247.389	316.866			
18 Start	243.229	317.008	5	4.7368126	low
18 End	247.389	314.743			
19 Start	243.229	313.101	11	4.7368126	low
19 End	247.389	315.366			
20 Start	234.579	307.619	35	15.095539	very high
20 End	249.669	308.028			
21 Start	242.529	311.889	18	6.7947001	medium
21 End	246.204	306.174			
22 Start	243.229	313.553	20	7.9555326	medium
22 End	246.204	306.174			
23 Start	236.799	303.073	30	11.178865	very high
23 End	245.164	310.489			
24 Start	240.744	312.189	15	4.6565471	medium
24 End	244.994	310.288			
25 Start	241.923	306.174	21	7.8479562	high
25 End	245.091	313.354			
26 Start	242.621	306.174	30	13.342063	very high
26 End	244.596	319.369			
27 Start	242.779	311.189	14	4.3581214	medium
27 End	245.137	314.854			
28 Start	234.579	311.423	38	15.953116	very high
28 End	250.509	312.282			
29 Start	241.551	312.189	13	4.2034144	medium
29 End	244.994	309.779			
30 Start	235.279	303.175	32	11.862057	very high
30 End	244.994	309.981			
31 Start	240.848	312.189	16	6.6675496	medium
31 End	243.725	306.174			
32 Start	241.925	312.189	15	6.1124382	medium
32 End	243.012	306.174			
33 Start	238.199	301.792	22	11.12033	high
33 End	242.858	311.889			
34 Start	236.45	300.939	26	12.276	high
34 End	241.363	312.189			
35 Start	237.969	300.939	24	11.709024	high
35 End	241.215	312.189			
36 Start	239.185	312.189	19	6.6744285	medium
36 End	242.078	306.174			
37 Start	239.575	312.189	19	11.296516	medium
37 End	240.599	300.939			
38 Start	235.279	301.953	17	5.415648	medium
38 End	240.599	300.939			
39 Start	237.709	312.189	23	11.615264	high
39 End	240.599	300.939			
40 Start	235.805	312.189	25	11.451023	high
40 End	240.599	301.79			

15 Start	264.377	306.826	11	5.5606508	medium
15 End	266.482	311.972			
16 Start	263.782	311.972	16	6.5964007	medium
16 End	266.732	306.072			
17 Start	258.682	304.236	17	10.715468	high
17 End	269.047	306.955			
18 Start	258.982	306.072	14	10.065358	medium
18 End	269.047	306.157			
19 Start	258.982	307.946	33	10.226861	very high
19 End	269.047	306.134			
20 Start	258.682	302.657	10	7.8170094	medium
20 End	266.492	302.988			
21 Start	262.932	311.972	14	5.3834419	medium
21 End	264.511	306.826			
22 Start	262.836	306.83	16	5.602602	medium
22 End	265.061	311.972			
23 Start	262.241	301.807	6	4.9739795	low
23 End	264.882	306.022			
24 Start	262.084	306.022	6	4.9739795	low
24 End	264.725	301.807			
25 Start	263.163	306.072	13	6.0172105	medium
25 End	264.345	311.972			
26 Start	263.092	311.972	15	5.903872	medium
26 End	263.306	306.072			
27 Start	261.457	309.926	16	3.8540645	medium
27 End	263.304	306.544			
28 Start	263.075	306.78	13	5.2200832	medium
28 End	263.616	311.972			
29 Start	261.457	310.011	15	3.6244526	medium
29 End	263.1	306.78			
30 Start	261.457	307.708	18	4.8211846	high
30 End	263.707	311.972			
31 Start	260.163	301.807	5	5.2879653	low
31 End	263.356	306.022			
32 Start	260.029	306.022	5	5.2427392	low
32 End	263.147	301.807			
33 Start	261.437	310.949	14	3.3908403	medium
33 End	262.757	307.826			
34 Start	261.516	311.672	19	5.0347261	high
34 End	262.896	306.83			
35 Start	260.975	310.899	15	3.2224853	medium
35 End	262.757	308.215			
36 Start	261.011	306.783	17	3.2096314	high
36 End	262.757	309.476			
37 Start	261.084	306.783	24	5.7415566	high
37 End	263.541	311.972			
38 Start	258.982	306.809	17	5.7147455	high
38 End	261.983	311.672			
39 Start	261.44	306.83	21	4.8432364	high
39 End	261.554	311.672			
40 Start	258.982	306.758	18	3.974005	high
40 End	262.757	308			

41 Start	235.279	300.939	17	5.4104519	medium
41 End	240.599	301.925			
42 Start	236.591	300.939	24	11.627012	high
42 End	239.527	312.189			
43 Start	236.457	303.959	20	8.8295755	medium
43 End	239.655	312.189			
44 Start	236.371	305.354	17	7.6301312	medium
44 End	239.762	312.189			
45 Start	238.109	300.939	23	11.321475	high
45 End	239.379	312.189			
46 Start	237.47	312.189	21	7.040318	high
46 End	240.599	305.883			
47 Start	237.839	300.939	20	8.3683596	medium
47 End	241.276	308.569			
48 Start	235.956	312.189	24	11.779424	high
48 End	239.448	300.939			
49 Start	237.836	312.189	22	11.345367	high
49 End	239.304	300.939			
50 Start	236.194	305.304	16	4.7874036	medium
50 End	238.16	300.939			
51 Start	236.488	307.519	17	6.7471571	medium
51 End	237.981	300.939			
52 Start	236.33	312.189	21	11.360734	high
52 End	237.912	300.939			
53 Start	235.77	307.569	11	5.157455	low
53 End	238.062	312.189			
54 Start	236.734	300.939	21	11.286987	high
54 End	237.647	312.189			
55 Start	236.633	305.354	12	6.9218554	medium
55 End	237.726	312.189			
56 Start	235.279	301.362	19	10.068556	medium
56 End	239.266	310.608			
57 Start	235.279	300.939	7	4.655509	low
57 End	236.898	305.304			
58 Start	235.279	305.304	8	4.5753446	low
58 End	236.651	300.939			
59 Start	234.879	307.569	5	4.7886214	low
59 End	236.139	312.189			
60 Start	235.329	312.189	4	4.6705427	low
60 End	236.015	307.569			

41 Start	261.131	310.899	19	4.4613361	high
41 End	262.96	306.83			
42 Start	261.437	310.949	19	4.1204195	high
42 End	261.546	306.83			
43 Start	260.707	310.899	13	4.8502769	medium
43 End	261.18	306.072			
44 Start	258.982	311.672	14	5.4023776	medium
44 End	261.275	306.78			
45 Start	258.682	311.222	14	5.2397985	medium
45 End	261.54	306.83			
46 Start	258.682	308.849	14	4.2635412	medium
46 End	262.438	306.83			
47 Start	258.682	308.687	22	6.19625	high
47 End	263.936	311.972			
48 Start	258.982	306.56	15	5.0620685	medium
48 End	261.504	310.949			
49 Start	261.011	306.783	12	4.116528	medium
49 End	261.067	310.899			
50 Start	258.982	301.807	4	4.7060022	low
50 End	261.075	306.022			
51 Start	258.982	306.022	4	4.6449604	low
51 End	260.934	301.807			
52 Start	259.048	306.072	11	5.621871	medium
52 End	259.543	311.672			

APPENDIX 5.1 – Observation Sheet for Maly Kack in December

Occupancy Counts	Points																			
Days_Times	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	Observer	Date	Day
Day1_09-12 (Morning)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	Researcher	12/4/2024	Wednesday
Day1_12-15 (Midday)	1	2	6	2	3	2	1	3	2	1	0	0	0	0	2	0	1	Researcher	12/4/2024	Wednesday
Day1_15-18 (Afternoon)	0	0	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	Researcher	12/4/2024	Wednesday
Day2_09-12 (Morning)	1	1	0	0	1	0	0	2	0	0	0	1	0	0	0	0	0	Researcher	12/5/2024	Thursday
Day2_12-15 (Midday)	3	2	2	0	0	0	2	0	0	0	0	0	0	0	1	1	1	Researcher	12/5/2024	Thursday
Day2_15-18 (Afternoon)	2	1	1	2	1	0	0	2	1	0	2	0	0	0	0	0	0	Researcher	12/5/2024	Thursday
Day3_09-12 (Morning)	0	3	0	0	0	0	0	0	0	0	0	0	0	0	0	4	0	Researcher	12/6/2024	Friday
Day3_12-15 (Midday)	2	0	3	3	0	0	0	0	0	0	3	0	0	0	0	1	1	Researcher	12/6/2024	Friday
Day3_15-18 (Afternoon)	2	2	3	3	0	0	0	0	0	0	0	0	0	0	0	0	0	Researcher	12/6/2024	Friday
Day4_09-12 (Morning)	2	0	2	2	1	0	3	0	0	0	1	0	0	1	0	2	1	Researcher	12/7/2024	Saturday
Day4_12-15 (Midday)	4	3	2	0	1	4	3	5	2	1	2	4	1	2	2	3	3	Researcher	12/7/2024	Saturday
Day4_15-18 (Afternoon)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	Researcher	12/7/2024	Saturday
Day5_09-12 (Morning)	4	3	2	1	0	4	2	2	2	0	1	1	0	0	0	0	1	Librarians	12/9/2024	Monday
Day5_12-15 (Midday)	4	3	3	2	3	2	2	1	0	0	1	1	0	0	0	0	0	Librarians	12/9/2024	Monday
Day5_15-18 (Afternoon)	2	0	2	0	2	0	0	0	3	0	0	0	0	1	0	0	1	Librarians	12/9/2024	Monday
Day6_09-12 (Morning)	1	0	1	0	2	0	0	0	1	0	0	1	0	0	0	0	0	Librarians	12/10/2024	Tuesday
Day6_12-15 (Midday)	2	0	1	0	0	0	0	0	3	0	0	1	0	0	0	0	0	Librarians	12/10/2024	Tuesday
Day6_15-18 (Afternoon)	4	0	4	0	0	0	1	0	1	0	1	0	0	2	0	2	0	Librarians	12/10/2024	Tuesday
Day7_09-12 (Morning)	1	0	0	0	0	3	0	1	1	0	0	1	0	1	0	0	0	Librarians	12/12/2024	Thursday
Day7_12-15 (Midday)	1	3	1	0	0	0	0	0	1	0	1	0	0	1	0	0	0	Librarians	12/12/2024	Thursday
Day7_15-18 (Afternoon)	1	3	1	0	0	0	0	0	1	0	3	1	0	0	0	0	0	Librarians	12/12/2024	Thursday

Sum value Day1	1	2	9	2	3	2	1	3	2	1	0	0	0	0	2	0	1
Sum value Day2	6	4	3	2	2	0	2	4	1	0	2	1	0	0	1	1	1
Sum value Day3	4	5	6	6	0	0	0	0	0	0	3	0	0	0	0	5	1
Sum value Day4	6	3	4	2	2	4	6	5	2	1	3	4	1	3	2	5	4
Sum value Day5	10	6	7	3	5	6	4	3	5	0	2	2	0	1	0	0	2
Sum value Day6	7	0	6	0	2	0	1	0	5	0	1	2	0	2	0	2	0
Sum value Day7	3	6	2	0	0	3	0	1	3	0	4	2	0	2	0	0	0
Sum value all days	37	26	37	15	14	15	14	16	18	2	15	11	1	8	5	13	9
Average Occupancy Counts	9	4	6	3	2	2	2	3	1	1	2	1	0	1	1	3	2
Max average Occupancy Counts	9																
Max count within time ranges	6																

Sum value for mornings	9	7	5	3	4	7	5	5	4	0	2	4	0	2	0	6	2
sum value for middays	17	13	18	7	7	8	8	9	8	2	7	6	1	3	5	5	6
sum values for afternoons	11	6	14	5	3	0	1	2	6	0	6	1	0	3	0	2	1

Occupancy Time (Minutes)	Points																		
Days_Times	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	Observer	Date	Day
Day1_09-12 (Morning)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	Researcher	12/4/2024	Wednesday
Day1_09-12 (Morning)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	Researcher	12/4/2024	Wednesday
Day1_09-12 (Morning)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	Researcher	12/4/2024	Wednesday
Day1_09-12 (Morning)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	Researcher	12/4/2024	Wednesday
Day1_09-12 (Morning)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	Researcher	12/4/2024	Wednesday
Day1_09-12 (Morning)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	Researcher	12/4/2024	Wednesday
Day1_12-15 (Midday)	90	5	30	60	20	30	20	10	10	30	0	0	0	0	150	0	10	Researcher	12/4/2024	Wednesday
Day1_12-15 (Midday)	0	60	90	60	30	30	0	0	10	0	0	0	0	0	150	0	0	Researcher	12/4/2024	Wednesday
Day1_12-15 (Midday)	0	0	90	0	60	0	0	0	0	0	0	0	0	0	0	0	0	Researcher	12/4/2024	Wednesday
Day1_12-15 (Midday)	0	0	60	0	0	0	0	0	0	0	0	0	0	0	0	0	0	Researcher	12/4/2024	Wednesday
Day1_12-15 (Midday)	0	0	60	0	0	0	0	0	0	0	0	0	0	0	0	0	0	Researcher	12/4/2024	Wednesday
Day1_12-15 (Midday)	0	0	60	0	0	0	0	0	0	0	0	0	0	0	0	0	0	Researcher	12/4/2024	Wednesday
Day1_15-18 (Afternoon)	0	0	60	0	0	0	0	0	0	0	0	0	0	0	0	0	0	Researcher	12/4/2024	Wednesday
Day1_15-18 (Afternoon)	0	0	60	0	0	0	0	0	0	0	0	0	0	0	0	0	0	Researcher	12/4/2024	Wednesday
Day1_15-18 (Afternoon)	0	0	60	0	0	0	0	0	0	0	0	0	0	0	0	0	0	Researcher	12/4/2024	Wednesday
Day1_15-18 (Afternoon)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	Researcher	12/4/2024	Wednesday
Day1_15-18 (Afternoon)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	Researcher	12/4/2024	Wednesday
Day1_15-18 (Afternoon)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	Researcher	12/4/2024	Wednesday
Day2_09-12 (Morning)	120	20	0	0	120	0	0	90	0	0	0	5	0	0	0	0	0	Researcher	12/5/2024	Thursday
Day2_09-12 (Morning)	0	0	0	0	0	0	0	90	0	0	0	0	0	0	0	0	0	Researcher	12/5/2024	Thursday
Day2_09-12 (Morning)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	Researcher	12/5/2024	Thursday
Day2_09-12 (Morning)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	Researcher	12/5/2024	Thursday
Day2_09-12 (Morning)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	Researcher	12/5/2024	Thursday
Day2_09-12 (Morning)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	Researcher	12/5/2024	Thursday
Day2_12-15 (Midday)	10	120	60	0	0	0	20	0	0	0	0	0	0	0	90	120	120	Researcher	12/5/2024	Thursday
Day2_12-15 (Midday)	60	120	60	0	0	0	20	0	0	0	0	0	0	0	0	0	0	Researcher	12/5/2024	Thursday
Day2_12-15 (Midday)	60	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	Researcher	12/5/2024	Thursday
Day2_12-15 (Midday)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	Researcher	12/5/2024	Thursday
Day2_12-15 (Midday)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	Researcher	12/5/2024	Thursday
Day2_12-15 (Midday)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	Researcher	12/5/2024	Thursday
Day2_15-18 (Afternoon)	60	30	60	60	30	0	0	60	15	0	40	0	0	0	0	0	0	Researcher	12/5/2024	Thursday
Day2_15-18 (Afternoon)	60	0	0	60	0	0	0	60	0	0	60	0	0	0	0	0	0	Researcher	12/5/2024	Thursday
Day2_15-18 (Afternoon)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	Researcher	12/5/2024	Thursday
Day2_15-18 (Afternoon)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	Researcher	12/5/2024	Thursday
Day2_15-18 (Afternoon)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	Researcher	12/5/2024	Thursday
Day2_15-18 (Afternoon)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	Researcher	12/5/2024	Thursday
Day3_09-12 (Morning)	0	30	0	0	0	0	0	0	0	0	0	0	0	0	0	30	0	Researcher	12/6/2024	Friday
Day3_09-12 (Morning)	0	30	0	0	0	0	0	0	0	0	0	0	0	0	0	30	0	Researcher	12/6/2024	Friday
Day3_09-12 (Morning)	0	30	0	0	0	0	0	0	0	0	0	0	0	0	0	30	0	Researcher	12/6/2024	Friday
Day3_09-12 (Morning)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	30	0	Researcher	12/6/2024	Friday
Day3_09-12 (Morning)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	Researcher	12/6/2024	Friday
Day3_09-12 (Morning)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	Researcher	12/6/2024	Friday
Day3_12-15 (Midday)	30	0	20	20	0	10	0	0	0	0	20	0	0	0	0	120	10	Researcher	12/6/2024	Friday
Day3_12-15 (Midday)	30	0	20	20	0	60	0	0	0	0	20	0	0	0	0	0	0	Researcher	12/6/2024	Friday
Day3_12-15 (Midday)	0	0	20	20	0	0	0	0	0	0	20	0	0	0	0	0	0	Researcher	12/6/2024	Friday
Day3_12-15 (Midday)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	Researcher	12/6/2024	Friday

Day3_12-15 (Midday)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	Researcher	12/6/2024	Friday
Day3_12-15 (Midday)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	Researcher	12/6/2024	Friday
Day3_15-18 (Afternoon)	60	30	60	60	0	0	0	0	0	0	0	0	0	0	0	0	0	Researcher	12/6/2024	Friday
Day3_15-18 (Afternoon)	60	30	30	60	0	0	0	0	0	0	0	0	0	0	0	0	0	Researcher	12/6/2024	Friday
Day3_15-18 (Afternoon)	0	0	30	60	0	0	0	0	0	0	0	0	0	0	0	0	0	Researcher	12/6/2024	Friday
Day3_15-18 (Afternoon)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	Researcher	12/6/2024	Friday
Day3_15-18 (Afternoon)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	Researcher	12/6/2024	Friday
Day3_15-18 (Afternoon)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	Researcher	12/6/2024	Friday
Day4_09-12 (Morning)	60	0	60	60	80	0	90	0	0	0	80	0	0	10	0	10	10	Researcher	12/7/2024	Saturday
Day4_09-12 (Morning)	60	0	60	15	0	0	90	0	0	0	0	0	0	0	0	10	0	Researcher	12/7/2024	Saturday
Day4_09-12 (Morning)	0	0	0	0	0	0	30	0	0	0	0	0	0	0	0	0	0	Researcher	12/7/2024	Saturday
Day4_09-12 (Morning)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	Researcher	12/7/2024	Saturday
Day4_09-12 (Morning)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	Researcher	12/7/2024	Saturday
Day4_09-12 (Morning)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	Researcher	12/7/2024	Saturday
Day4_12-15 (Midday)	60	10	10	0	30	20	10	30	10	10	120	60	40	90	30	90	30	Researcher	12/7/2024	Saturday
Day4_12-15 (Midday)	60	10	60	0	0	20	10	30	10	0	15	60	0	90	30	90	30	Researcher	12/7/2024	Saturday
Day4_12-15 (Midday)	0	2	0	0	0	15	10	30	0	0	0	20	0	0	0	90	30	Researcher	12/7/2024	Saturday
Day4_12-15 (Midday)	0	0	0	0	0	15	0	30	0	0	0	20	0	0	0	0	0	Researcher	12/7/2024	Saturday
Day4_12-15 (Midday)	0	0	0	0	0	0	0	30	0	0	0	0	0	0	0	0	0	Researcher	12/7/2024	Saturday
Day4_12-15 (Midday)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	Researcher	12/7/2024	Saturday
Day4_15-18 (Afternoon)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	Researcher	12/7/2024	Saturday
Day4_15-18 (Afternoon)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	Researcher	12/7/2024	Saturday
Day4_15-18 (Afternoon)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	Researcher	12/7/2024	Saturday
Day4_15-18 (Afternoon)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	Researcher	12/7/2024	Saturday
Day4_15-18 (Afternoon)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	Researcher	12/7/2024	Saturday
Day4_15-18 (Afternoon)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	Researcher	12/7/2024	Saturday
Day5_09-12 (Morning)	30	30	60	30	0	120	120	60	30	0	150	5	0	0	0	0	50	Librarian	12/7/2024	Monday
Day5_09-12 (Morning)	30	30	30	0	0	120	120	60	30	0	0	0	0	0	0	0	0	Librarian	12/7/2024	Monday
Day5_09-12 (Morning)	30	30	0	0	0	120	0	0	0	0	0	0	0	0	0	0	0	Librarian	12/7/2024	Monday
Day5_09-12 (Morning)	30	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	Librarian	12/9/2024	Monday
Day5_09-12 (Morning)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	Librarian	12/9/2024	Monday
Day5_09-12 (Morning)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	Librarian	12/9/2024	Monday
Day5_12-15 (Midday)	30	60	30	30	120	40	60	15	0	0	5	20	0	0	0	0	0	Librarian	12/9/2024	Monday
Day5_12-15 (Midday)	30	60	30	30	120	40	60	0	0	0	0	0	0	0	0	0	0	Librarian	12/9/2024	Monday
Day5_12-15 (Midday)	30	60	30	0	120	0	0	0	0	0	0	0	0	0	0	0	0	Librarian	12/9/2024	Monday
Day5_12-15 (Midday)	30	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	Librarian	12/9/2024	Monday
Day5_12-15 (Midday)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	Librarian	12/9/2024	Monday
Day5_12-15 (Midday)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	Librarian	12/9/2024	Monday
Day5_15-18 (Afternoon)	30	0	30	0	25	0	0	0	60	0	0	0	0	20	0	0	10	Librarian	12/9/2024	Monday
Day5_15-18 (Afternoon)	30	0	30	0	25	0	0	0	60	0	0	0	0	0	0	0	0	Librarian	12/9/2024	Monday
Day5_15-18 (Afternoon)	0	0	0	0	0	0	0	0	60	0	0	0	0	0	0	0	0	Librarian	12/9/2024	Monday
Day5_15-18 (Afternoon)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	Librarian	12/9/2024	Monday
Day5_15-18 (Afternoon)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	Librarian	12/9/2024	Monday
Day5_15-18 (Afternoon)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	Librarian	12/9/2024	Monday
Day6_09-12 (Morning)	30	0	30	0	60	0	0	0	120	0	0	60	0	0	0	0	0	Librarian	12/9/2024	Tuesday
Day6_09-12 (Morning)	0	0	0	0	60	0	0	0	0	0	0	0	0	0	0	0	0	Librarian	12/9/2024	Tuesday
Day6_09-12 (Morning)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	Librarian	12/9/2024	Tuesday
Day6_09-12 (Morning)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	Librarian	12/10/2024	Tuesday
Day6_09-12 (Morning)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	Librarian	12/10/2024	Tuesday

APPENDIX 5.1

Day6_09-12 (Morning)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	Librarian	12/10/2024	Tuesday
Day6_12-15 (Midday)	30	0	30	0	0	0	0	0	40	0	0	120	0	0	0	0	0	Librarian	12/10/2024	Tuesday
Day6_12-15 (Midday)	30	0	0	0	0	0	0	0	40	0	0	0	0	0	0	0	0	Librarian	12/10/2024	Tuesday
Day6_12-15 (Midday)	0	0	0	0	0	0	0	0	40	0	0	0	0	0	0	0	0	Librarian	12/10/2024	Tuesday
Day6_12-15 (Midday)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	Librarian	12/10/2024	Tuesday
Day6_12-15 (Midday)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	Librarian	12/10/2024	Tuesday
Day6_12-15 (Midday)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	Librarian	12/10/2024	Tuesday
Day6_15-18 (Afternoon)	30	0	30	0	0	0	50	0	120	0	5	0	0	20	0	50	0	Librarian	12/10/2024	Tuesday
Day6_15-18 (Afternoon)	30	0	30	0	0	0	0	0	0	0	0	0	0	50	0	50	0	Librarian	12/10/2024	Tuesday
Day6_15-18 (Afternoon)	30	0	30	0	0	0	0	0	0	0	0	0	0	0	0	0	0	Librarian	12/10/2024	Tuesday
Day6_15-18 (Afternoon)	30	0	30	0	0	0	0	0	0	0	0	0	0	0	0	0	0	Librarian	12/10/2024	Tuesday
Day6_15-18 (Afternoon)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	Librarian	12/10/2024	Tuesday
Day6_15-18 (Afternoon)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	Librarian	12/10/2024	Tuesday
Day7_09-12 (Morning)	60	0	0	0	0	50	0	60	60	0	0	50	0	10	0	0	0	Librarian	12/10/2024	Thursday
Day7_09-12 (Morning)	0	0	0	0	0	50	0	0	0	0	0	0	0	0	0	0	0	Librarian	12/10/2024	Thursday
Day7_09-12 (Morning)	0	0	0	0	0	50	0	0	0	0	0	0	0	0	0	0	0	Librarian	12/10/2024	Thursday
Day7_09-12 (Morning)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	Librarian	12/12/2024	Thursday
Day7_09-12 (Morning)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	Librarian	12/12/2024	Thursday
Day7_09-12 (Morning)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	Librarian	12/12/2024	Thursday
Day7_12-15 (Midday)	30	60	30	0	0	0	0	0	120	0	120	0	0	70	0	0	0	Librarian	12/12/2024	Thursday
Day7_12-15 (Midday)	0	60	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	Librarian	12/12/2024	Thursday
Day7_12-15 (Midday)	0	60	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	Librarian	12/12/2024	Thursday
Day7_12-15 (Midday)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	Librarian	12/12/2024	Thursday
Day7_12-15 (Midday)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	Librarian	12/12/2024	Thursday
Day7_12-15 (Midday)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	Librarian	12/12/2024	Thursday
Day7_15-18 (Afternoon)	30	60	30	30	10	10	60	60	90	120	20	35	0	0	0	0	0	Librarian	12/12/2024	Thursday
Day7_15-18 (Afternoon)	30	60	30	30	0	10	0	0	90	120	20	0	0	0	0	0	0	Librarian	12/12/2024	Thursday
Day7_15-18 (Afternoon)	30	60	0	30	0	10	0	0	90	120	20	0	0	0	0	0	0	Librarian	12/12/2024	Thursday
Day7_15-18 (Afternoon)	30	60	0	0	0	10	0	0	0	0	0	0	0	0	0	0	0	Librarian	12/12/2024	Thursday
Day7_15-18 (Afternoon)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	Librarian	12/12/2024	Thursday
Day7_15-18 (Afternoon)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	Librarian	12/12/2024	Thursday

Sum value Day1	90	65	570	120	110	60	20	10	20	30	0	0	0	0	300	0	10
Sum value Day2	370	290	180	120	150	0	40	300	15	0	100	5	0	0	90	120	120
Sum value Day3	180	150	180	240	0	70	0	0	0	0	60	0	0	0	0	240	10
Sum value Day4	240	22	190	75	110	70	240	150	20	10	135	160	40	180	60	270	90
Sum value Day5	300	270	240	90	410	440	360	135	240	0	155	25	0	20	0	0	60
Sum value Day6	210	0	180	0	120	0	50	0	360	0	5	180	0	70	0	100	0
Sum value Day7	210	420	90	90	10	190	60	120	450	360	180	85	0	80	0	0	0

Sum value for mornings	450	200	240	105	320	510	450	360	240	0	285	280	40	190	60	390	140
sum value for middays	610	687	790	240	500	280	210	175	280	40	320	300	40	250	450	510	230
sum values for afternoons	540	330	600	390	90	40	110	180	585	360	165	35	0	90	0	100	10

Average time spent	13	10	13	6	7	7	6	6	9	3	6	4	0	3	4	6	2

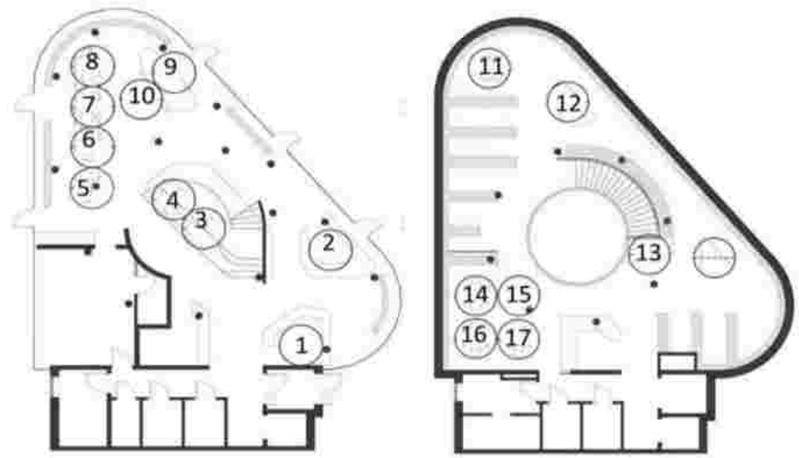
Max time withing time ranges	150
Max average time spent	13
Max Average occupancy efficacy	120

	Points																
occupancy data	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
Utilization score	117	34	71	18	13	10	14	17	11	2	11	5	0	2	4	16	4
Normalized efficacy	1.0	0.3	0.6	0.1	0.1	0.1	0.1	0.1	0.1	0.0	0.1	0.0	0.0	0.0	0.0	0.1	0.0
Balanced efficacy	2.07	1.54	1.86	1.27	1.13	1.04	1.17	1.26	1.08	0.41	1.09	0.74	0.03	0.50	0.74	1.24	0.71
BE-Bemin	2.04	1.51	1.83	1.23	1.10	1.00	1.14	1.22	1.04	0.38	1.06	0.71	0.00	0.46	0.70	1.21	0.68
Balanced relative efficacy	1.0000	0.7393	0.8945	0.6048	0.5399	0.4918	0.5566	0.5992	0.5120	0.1861	0.5188	0.3471	0.0000	0.2275	0.3452	0.5914	0.3333

BE max	2.07
BE min	0.03
BEmax-BEmin	2.04

Balanced Efficacy (Balanced Utilization score)=
BE = Log (1 + (Average Occupancy Counts × Average Time Spent))

Balanced Relative Efficacy (time-specific) $= \dfrac{\textbf{BE - BEmin}}{\textbf{BEmax - BEmin}}$



APPENDIX 5.1 – Observation Sheet for Maly Kack in March

Occupancy Counts	Points																			
Days_Times	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	Observer	Date	Day
Day1_09-12 (Morning)	0	0	1	2	0	0	0	0	0	0	1	0	0	0	0	1	0	Researcher	10/3/2025	Monday
Day1_12-15 (Midday)	3	0	3	5	2	0	0	0	2	0	2	1	0	1	2	1	1	Researcher	10/3/2025	Monday
Day1_15-18 (Afternoon)	2	2	5	6	4	2	2	0	3	0	2	1	0	0	0	0	1	Researcher	10/3/2025	Monday
Day2_09-12 (Morning)	0	0	0	0	0	1	0	0	0	0	0	0	0	1	0	0	0	Researcher	11/3/2025	Tuesday
Day2_12-15 (Midday)	1	0	0	0	0	0	0	0	0	0	2	1	0	1	0	0	1	Researcher	11/3/2025	Tuesday
Day2_15-18 (Afternoon)	3	3	3	4	0	0	3	0	4	0	3	1	0	3	2	0	1	Researcher	11/3/2025	Tuesday
Day3_09-12 (Morning)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	Researcher	12/3/2025	Wednesday
Day3_12-15 (Midday)	2	1	1	1	2	0	0	0	0	0	0	0	0	0	0	0	0	Researcher	12/3/2025	Wednesday
Day3_15-18 (Afternoon)	2	0	1	1	4	0	0	0	0	0	2	0	0	0	0	0	0	Researcher	12/3/2025	Wednesday
Day4_09-12 (Morning)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	Librarian	17/3/2025	Monday
Day4_12-15 (Midday)	2	2	2	0	3	0	0	0	1	0	3	0	1	1	0	0	0	Librarian	17/3/2025	Monday
Day4_15-18 (Afternoon)	4	4	6	0	4	1	2	2	0	1	0	0	0	5	5	4	1	Librarian	17/3/2025	Monday
Day5_09-12 (Morning)	0	0	0	0	0	0	0	0	1	0	1	0	0	0	0	0	0	Librarian	18/3/2025	Tuesday
Day5_12-15 (Midday)	6	5	6	2	4	0	0	0	1	0	1	0	0	1	0	2	0	Librarian	18/3/2025	Tuesday
Day5_15-18 (Afternoon)	3	0	3	0	0	0	1	3	0	0	1	0	0	0	0	0	0	Librarian	18/3/2025	Tuesday
Day6_09-12 (Morning)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	Librarian	19/3/2025	Wednesday
Day6_12-15 (Midday)	3	0	3	0	1	0	0	0	0	1	0	1	0	0	0	0	0	Librarian	19/3/2025	Wednesday
Day6_15-18 (Afternoon)	0	2	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	Librarian	19/3/2025	Wednesday
Day7_09-12 (Morning)	0	0	0	2	0	0	0	6	0	0	1	0	0	0	0	0	0	Researcher	20/3/2025	Thursday
Day7_12-15 (Midday)	1	0	1	2	0	0	0	0	0	0	2	0	0	0	1	0	1	Researcher	20/3/2025	Thursday
Day7_15-18 (Afternoon)	3	6	5	6	3	2	2	5	6	0	5	2	0	2	1	0	1	Researcher	20/3/2025	Thursday

Sum value Day1	5	2	9	13	6	2	2	0	5	0	5	2	0	1	2	2	2
Sum value Day2	4	3	3	4	0	1	3	0	4	0	5	2	0	5	2	0	2
Sum value Day3	4	1	2	2	6	0	0	0	0	0	2	0	0	0	0	0	0
Sum value Day4	6	6	8	0	7	1	2	2	1	1	3	0	1	1	0	0	0
Sum value Day5	9	5	9	2	4	0	1	3	2	0	3	0	0	6	5	6	1
Sum value Day6	3	2	3	0	1	0	0	0	0	1	0	1	0	0	1	0	0
Sum value Day7	4	6	6	10	3	2	2	11	6	0	8	2	0	2	2	0	2
Sum value all days	35	25	40	31	27	6	10	16	18	2	26	7	1	15	12	8	7
Average Occupancy Counts	9	3	6	5	5	1	2	1	3	0	4	1	0	2	1	1	1
Max average Occupancy Counts	9																
Max count within time ranges	6																

Sum value for mornings	0	0	1	4	0	1	0	6	1	0	3	0	0	1	0	1	0
sum value for middays	18	8	16	10	12	0	0	0	4	1	7	3	0	3	3	3	3
sum values for afternoons	17	17	23	17	15	5	10	10	13	1	16	4	1	6	4	0	3

Occupancy Time (Minutes)	Points																		
Days_Times	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	Observer	Date	Day
Day1_09-12 (Morning)	0	0	120	60	0	0	0	0	0	0	30	0	0	0	0	60	0	Researcher	10/3/2025	Monday
Day1_09-12 (Morning)	0	0	0	60	0	0	0	0	0	0	0	0	0	0	0	0	0	Researcher	10/3/2025	Monday
Day1_09-12 (Morning)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	Researcher	10/3/2025	Monday
Day1_09-12 (Morning)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	Researcher	10/3/2025	Monday
Day1_09-12 (Morning)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	Researcher	10/3/2025	Monday
Day1_09-12 (Morning)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	Researcher	10/3/2025	Monday
Day1_12-15 (Midday)	60	120	120	60	60	0	0	0	30	0	90	10	0	120	30	30	180	Researcher	10/3/2025	Monday
Day1_12-15 (Midday)	60	120	120	60	60	0	0	0	60	0	120	0	0	0	90	0	0	Researcher	10/3/2025	Monday
Day1_12-15 (Midday)	120	0	120	60	0	0	0	0	0	0	0	0	0	0	0	0	0	Researcher	10/3/2025	Monday
Day1_12-15 (Midday)	0	0	0	60	0	0	0	0	0	0	0	0	0	0	0	0	0	Researcher	10/3/2025	Monday
Day1_12-15 (Midday)	0	0	0	60	0	0	0	0	0	0	0	0	0	0	0	0	0	Researcher	10/3/2025	Monday
Day1_12-15 (Midday)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	Researcher	10/3/2025	Monday
Day1_15-18 (Afternoon)	60	10	60	120	10	30	60	0	30	0	60	30	0	0	0	0	180	Researcher	10/3/2025	Monday
Day1_15-18 (Afternoon)	60	10	60	120	10	30	60	0	60	0	30	0	0	0	0	0	0	Researcher	10/3/2025	Monday
Day1_15-18 (Afternoon)	0	0	90	120	30	0	0	0	30	0	30	0	0	0	0	0	0	Researcher	10/3/2025	Monday
Day1_15-18 (Afternoon)	0	0	90	120	60	0	0	0	0	0	0	0	0	0	0	0	0	Researcher	10/3/2025	Monday
Day1_15-18 (Afternoon)	0	0	90	180	0	0	0	0	0	0	0	0	0	0	0	0	0	Researcher	10/3/2025	Monday
Day1_15-18 (Afternoon)	0	0	0	180	0	0	0	0	0	0	0	0	0	0	0	0	0	Researcher	10/3/2025	Monday
Day2_09-12 (Morning)	0	0	0	0	0	30	0	0	0	0	0	0	0	10	0	0	0	Researcher	11//3/2025	Tuesday
Day2_09-12 (Morning)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	Researcher	11/3/2025	Tuesday
Day2_09-12 (Morning)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	Researcher	11/3/2025	Tuesday
Day2_09-12 (Morning)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	Researcher	11/3/2025	Tuesday
Day2_09-12 (Morning)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	Researcher	11/3/2025	Tuesday
Day2_09-12 (Morning)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	Researcher	11/3/2025	Tuesday
Day2_12-15 (Midday)	60	0	0	0	0	0	0	0	0	0	10	10	0	30	0	0	180	Researcher	11/3/2025	Tuesday
Day2_12-15 (Midday)	0	0	0	0	0	0	0	0	0	0	90	0	0	0	0	0	180	Researcher	11/3/2025	Tuesday
Day2_12-15 (Midday)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	Researcher	11/3/2025	Tuesday
Day2_12-15 (Midday)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	Researcher	11/3/2025	Tuesday
Day2_12-15 (Midday)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	Researcher	11/3/2025	Tuesday
Day2_12-15 (Midday)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	Researcher	11/3/2025	Tuesday
Day2_15-18 (Afternoon)	60	10	40	60	0	0	120	0	30	0	30	5	0	30	60	0	60	Researcher	11/3/2025	Tuesday
Day2_15-18 (Afternoon)	90	60	60	60	0	0	120	0	30	0	30	0	0	30	60	0	0	Researcher	11/3/2025	Tuesday
Day2_15-18 (Afternoon)	0	60	60	120	0	0	120	0	60	0	60	0	0	30	0	0	0	Researcher	11/3/2025	Tuesday
Day2_15-18 (Afternoon)	0	0	0	120	0	0	0	0	60	0	0	0	0	0	0	0	0	Researcher	11/3/2025	Tuesday
Day2_15-18 (Afternoon)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	Researcher	11/3/2025	Tuesday
Day2_15-18 (Afternoon)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	Researcher	11/3/2025	Tuesday
Day3_09-12 (Morning)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	Researcher	12/3/2025	Wednesday
Day3_09-12 (Morning)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	Researcher	12/3/2025	Wednesday
Day3_09-12 (Morning)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	Researcher	12/3/2025	Wednesday
Day3_09-12 (Morning)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	Researcher	12/3/2025	Wednesday
Day3_09-12 (Morning)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	Researcher	12/3/2025	Wednesday
Day3_09-12 (Morning)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	Researcher	12/3/2025	Wednesday
Day3_12-15 (Midday)	30	10	60	10	30	0	0	0	0	0	0	0	0	0	0	0	0	Researcher	12/3/2025	Wednesday
Day3_12-15 (Midday)	30	0	0	0	30	0	0	0	0	0	0	0	0	0	0	0	0	Researcher	12/3/2025	Wednesday
Day3_12-15 (Midday)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	Researcher	12/3/2025	Wednesday
Day3_12-15 (Midday)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	Researcher	12/3/2025	Wednesday
Day3_12-15 (Midday)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	Researcher	12/3/2025	Wednesday
Day3_12-15 (Midday)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	Researcher	12/3/2025	Wednesday
Day3_15-18 (Afternoon)	60	0	60	10	30	0	0	0	0	0	15	0	0	0	0	0	0	Researcher	12/3/2025	Wednesday

Day3_15-18 (Afternoon)	60	0	0	0	30	0	0	0	0	0	15	0	0	0	0	0	0	Researcher	12/3/2025 Wednesday
Day3_15-18 (Afternoon)	0	0	0	0	30	0	0	0	0	0	0	0	0	0	0	0	0	Researcher	12/3/2025 Wednesday
Day3_15-18 (Afternoon)	0	0	0	0	30	0	0	0	0	0	0	0	0	0	0	0	0	Researcher	12/3/2025 Wednesday
Day3_15-18 (Afternoon)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	Researcher	12/3/2025 Wednesday
Day3_15-18 (Afternoon)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	Researcher	12/3/2025 Wednesday
Day4_09-12 (Morning)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	Librarian	17/3/2025 Monday
Day4_09-12 (Morning)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	Librarian	17/3/2025 Monday
Day4_09-12 (Morning)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	Librarian	17/3/2025 Monday
Day4_09-12 (Morning)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	Librarian	17/3/2025 Monday
Day4_09-12 (Morning)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	Librarian	17/3/2025 Monday
Day4_09-12 (Morning)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	Librarian	17/3/2025 Monday
Day4_12-15 (Midday)	30	50	30	0	180	0	0	0	160	0	90	0	180	30	0	0	0	Librarian	17/3/2025 Monday
Day4_12-15 (Midday)	30	50	30	0	180	0	0	0	0	0	90	0	0	0	0	0	0	Librarian	17/3/2025 Monday
Day4_12-15 (Midday)	0	0	0	0	180	0	0	0	0	0	90	0	0	0	0	0	0	Librarian	17/3/2025 Monday
Day4_12-15 (Midday)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	Librarian	17/3/2025 Monday
Day4_12-15 (Midday)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	Librarian	17/3/2025 Monday
Day4_12-15 (Midday)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	Librarian	17/3/2025 Monday
Day4_15-18 (Afternoon)	30	30	90	0	20	20	50	90	0	30	0	0	0	60	60	60	120	Librarian	17/3/2025 Monday
Day4_15-18 (Afternoon)	30	30	90	0	20	0	50	90	0	0	0	0	0	60	60	60	0	Librarian	17/3/2025 Monday
Day4_15-18 (Afternoon)	30	40	90	0	20	0	0	0	0	0	0	0	0	60	60	60	0	Librarian	17/3/2025 Monday
Day4_15-18 (Afternoon)	30	40	90	0	20	0	0	0	0	0	0	0	0	60	60	60	0	Librarian	17/3/2025 Monday
Day4_15-18 (Afternoon)	0	0	90	0	0	0	0	0	0	0	0	0	0	60	60	0	0	Librarian	17/3/2025 Monday
Day4_15-18 (Afternoon)	0	0	90	0	0	0	0	0	0	0	0	0	0	0	0	0	0	Librarian	17/3/2025 Monday
Day5_09-12 (Morning)	0	0	0	0	0	0	0	0	180	0	180	0	0	0	0	0	0	Librarian	18/3/2025 Tuesday
Day5_09-12 (Morning)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	Librarian	18/3/2025 Tuesday
Day5_09-12 (Morning)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	Librarian	18/3/2025 Tuesday
Day5_09-12 (Morning)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	Librarian	18/3/2025 Tuesday
Day5_09-12 (Morning)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	Librarian	18/3/2025 Tuesday
Day5_09-12 (Morning)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	Librarian	18/3/2025 Tuesday
Day5_12-15 (Midday)	30	60	30	30	40	0	0	0	180	0	30	0	0	160	0	60	0	Librarian	18/3/2025 Tuesday
Day5_12-15 (Midday)	30	0	30	30	40	0	0	0	0	0	0	0	0	0	0	60	0	Librarian	18/3/2025 Tuesday
Day5_12-15 (Midday)	30	0	30	0	40	0	0	0	0	0	0	0	0	0	0	0	0	Librarian	18/3/2025 Tuesday
Day5_12-15 (Midday)	30	0	30	0	40	0	0	0	0	0	0	0	0	0	0	0	0	Librarian	18/3/2025 Tuesday
Day5_12-15 (Midday)	30	0	30	0	0	0	0	0	0	0	0	0	0	0	0	0	0	Librarian	18/3/2025 Tuesday
Day5_12-15 (Midday)	30	0	30	0	0	0	0	0	0	0	0	0	0	0	0	0	0	Librarian	18/3/2025 Tuesday
Day5_15-18 (Afternoon)	30	0	30	0	0	0	80	90	0	0	70	0	0	0	0	0	0	Librarian	18/3/2025 Tuesday
Day5_15-18 (Afternoon)	30	0	30	0	0	0	0	90	0	0	0	0	0	0	0	0	0	Librarian	18/3/2025 Tuesday
Day5_15-18 (Afternoon)	30	0	30	0	0	0	0	90	0	0	0	0	0	0	0	0	0	Librarian	18/3/2025 Tuesday
Day5_15-18 (Afternoon)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	Librarian	18/3/2025 Tuesday
Day5_15-18 (Afternoon)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	Librarian	18/3/2025 Tuesday
Day5_15-18 (Afternoon)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	Librarian	18/3/2025 Tuesday
Day6_09-12 (Morning)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	Librarian	19/3/2025 Wednesday
Day6_09-12 (Morning)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	Librarian	19/3/2025 Wednesday
Day6_09-12 (Morning)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	Librarian	19/3/2025 Wednesday
Day6_09-12 (Morning)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	Librarian	19/3/2025 Wednesday
Day6_09-12 (Morning)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	Librarian	19/3/2025 Wednesday
Day6_09-12 (Morning)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	Librarian	19/3/2025 Wednesday
Day6_12-15 (Midday)	30	0	30	0	10	0	0	0	0	25	0	0	0	0	0	0	0	Librarian	19/3/2025 Wednesday
Day6_12-15 (Midday)	30	0	30	0	0	0	0	0	0	0	0	0	0	0	0	0	0	Librarian	19/3/2025 Wednesday
Day6_12-15 (Midday)	30	0	30	0	0	0	0	0	0	0	0	0	0	0	0	0	0	Librarian	19/3/2025 Wednesday
Day6_12-15 (Midday)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	Librarian	19/3/2025 Wednesday
Day6_12-15 (Midday)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	Librarian	19/3/2025 Wednesday

Day6_12-15 (Midday)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	Librarian	19/3/2025	Wednesday
Day6_15-18 (Afternoon)	0	60	0	0	0	0	0	0	0	0	0	6	0	0	5	0	0	Librarian	19/3/2025	Wednesday
Day6_15-18 (Afternoon)	0	60	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	Librarian	19/3/2025	Wednesday
Day6_15-18 (Afternoon)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	Librarian	19/3/2025	Wednesday
Day6_15-18 (Afternoon)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	Librarian	19/3/2025	Wednesday
Day6_15-18 (Afternoon)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	Librarian	19/3/2025	Wednesday
Day6_15-18 (Afternoon)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	Librarian	19/3/2025	Wednesday
Day7_09-12 (Morning)	0	0	0	10	0	0	0	60	0	0	30	0	0	0	0	0	0	Researcher	20/3/2025	Thursday
Day7_09-12 (Morning)	0	0	0	10	0	0	0	60	0	0	0	0	0	0	0	0	0	Researcher	20/3/2025	Thursday
Day7_09-12 (Morning)	0	0	0	0	0	0	0	60	0	0	0	0	0	0	0	0	0	Researcher	20/3/2025	Thursday
Day7_09-12 (Morning)	0	0	0	0	0	0	0	60	0	0	0	0	0	0	0	0	0	Researcher	20/3/2025	Thursday
Day7_09-12 (Morning)	0	0	0	0	0	0	0	60	0	0	0	0	0	0	0	0	0	Researcher	20/3/2025	Thursday
Day7_09-12 (Morning)	0	0	0	0	0	0	0	60	0	0	0	0	0	0	0	0	0	Researcher	20/3/2025	Thursday
Day7_12-15 (Midday)	30	0	30	30	0	0	0	0	0	0	10	0	0	0	60	0	60	Researcher	20/3/2025	Thursday
Day7_12-15 (Midday)	0	0	0	30	0	0	0	0	0	0	10	0	0	0	0	0	0	Researcher	20/3/2025	Thursday
Day7_12-15 (Midday)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	Researcher	20/3/2025	Thursday
Day7_12-15 (Midday)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	Researcher	20/3/2025	Thursday
Day7_12-15 (Midday)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	Researcher	20/3/2025	Thursday
Day7_12-15 (Midday)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	Researcher	20/3/2025	Thursday
Day7_15-18 (Afternoon)	120	20	120	120	60	60	60	30	30	0	30	20	0	180	180	0	180	Researcher	20/3/2025	Thursday
Day7_15-18 (Afternoon)	120	20	120	120	60	60	60	30	30	0	30	20	0	180	0	0	0	Researcher	20/3/2025	Thursday
Day7_15-18 (Afternoon)	120	20	60	60	60	0	0	30	30	0	60	0	0	0	0	0	0	Researcher	20/3/2025	Thursday
Day7_15-18 (Afternoon)	0	20	60	60	0	0	0	60	30	0	60	0	0	0	0	0	0	Researcher	20/3/2025	Thursday
Day7_15-18 (Afternoon)	0	20	0	60	0	0	0	60	10	0	60	0	0	0	0	0	0	Researcher	20/3/2025	Thursday
Day7_15-18 (Afternoon)	0	20	0	60	0	0	0	0	10	0	0	0	0	0	0	0	0	Researcher	20/3/2025	Thursday

Sum value Day1	360	260	870	1260	230	60	120	0	210	0	360	40	0	120	120	90	360
Sum value Day2	210	130	160	360	0	30	360	0	180	0	220	15	0	130	120	0	420
Sum value Day3	180	10	120	20	180	0	0	0	0	0	30	0	0	0	0	0	0
Sum value Day4	180	240	600	0	620	20	100	180	160	30	270	0	180	330	300	240	120
Sum value Day5	270	60	270	60	160	0	80	270	360	0	280	0	0	160	0	120	0
Sum value Day6	90	120	90	0	10	0	0	0	0	25	0	6	0	0	5	0	0
Sum value Day7	390	120	390	560	180	120	120	570	140	0	290	40	0	360	240	0	240
Sum value for mornings	0	0	120	140	0	30	0	360	180	0	240	0	0	10	0	60	0
sum value for middays	720	410	780	430	890	0	0	0	430	25	630	20	180	340	180	150	600
sum values for afternoons	960	530	1600	1690	490	200	780	660	440	30	580	81	0	750	605	240	540
Average time spent	13	7	20	18	11	2	6	8	8	0	12	1	1	9	6	4	9

Max time withing time ranges	180
Max average time spent	20
Max Average occupancy efficacy	174

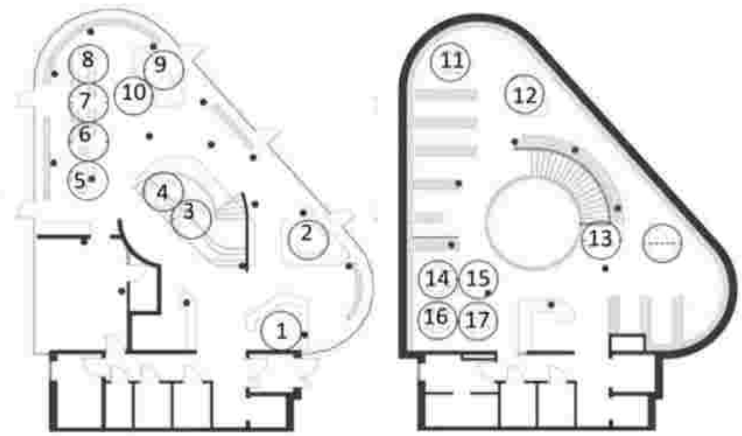
	Points																
occupancy data	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
Utilization score	117	22	109	85	52	2	11	4	21	0	43	1	0	15	6	2	9
Normalized efficacy	0.7	0.1	0.6	0.5	0.3	0.0	0.1	0.0	0.1	0.0	0.2	0.0	0.0	0.1	0.0	0.0	0.1
Balanced efficacy	2.07	1.37	2.04	1.94	1.72	0.45	1.07	0.70	1.34	0.04	1.64	0.26	0.13	1.21	0.86	0.44	1.00

BE-Bemin	2.03	1.32	2.00	1.89	1.68	0.41	1.03	0.66	1.29	0.00	1.60	0.21	0.09	1.17	0.81	0.40	0.96
Balanced relative efficacy	1.0000	0.6536	0.9858	0.9333	0.8291	0.2005	0.5075	0.3249	0.6389	0.0000	0.7899	0.1040	0.0433	0.5759	0.4019	0.1974	0.4725

BE max	2.07
BE min	0.04
BEmax-BEmin	2.03

Balanced Efficacy (Balanced Utilization score)=
BE = Log (1 + (Average Occupancy Counts × Average Time Spent))

Balanced Relative Efficacy (time-specific) $= \dfrac{\textbf{BE - BEmin}}{\textbf{BEmax - BEmin}}$



APPENDIX 5.1 – Observation Sheet for Maly Kack in June

Occupancy Counts	Points																			
Days_Times	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	Observer	Date	Day
Day1_09-12 (Morning)	0	0	0	2	0	0	0	2	0	0	0	0	0	1	0	0	0	Researcher	6/9/2025	Monday
Day1_12-15 (Midday)	0	1	0	2	0	0	2	2	0	0	0	1	0	1	1	1	0	Researcher	6/9/2025	Monday
Day1_15-18 (Afternoon)	4	8	6	5	3	4	4	5	4	1	2	2	0	2	0	1	0	Researcher	6/9/2025	Monday
Day2_09-12 (Morning)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	Librarian	6/10/2025	Tuesday
Day2_12-15 (Midday)	1	0	3	0	1	0	0	0	0	0	0	0	0	2	0	0	0	Librarian	6/10/2025	Tuesday
Day2_15-18 (Afternoon)	3	0	4	0	0	2	3	0	2	0	3	1	0	0	0	0	0	Librarian	6/10/2025	Tuesday
Day3_09-12 (Morning)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	Researcher	6/11/2025	Wednesday
Day3_12-15 (Midday)	0	2	2	1	0	0	0	0	0	0	1	0	0	1	0	1	0	Researcher	6/11/2025	Wednesday
Day3_15-18 (Afternoon)	3	2	3	0	0	3	0	1	4	3	4	1	0	1	0	0	0	Researcher	6/11/2025	Wednesday
Day4_09-12 (Morning)	2	0	0	0	0	0	0	0	0	0	1	1	0	1	0	0	0	Researcher	6/12/2025	Thursday
Day4_12-15 (Midday)	0	0	1	3	3	2	0	1	0	0	4	1	1	0	0	1	0	Researcher	6/12/2025	Thursday
Day4_15-18 (Afternoon)	2	4	5	4	4	7	3	3	5	0	2	0	0	0	0	0	1	Researcher	6/12/2025	Thursday
Day5_09-12 (Morning)	2	0	1	0	0	0	0	0	0	0	0	0	0	1	0	0	1	Researcher	6/13/2025	Friday
Day5_12-15 (Midday)	0	0	2	1	0	0	0	0	0	0	1	1	0	1	0	0	2	Researcher	6/13/2025	Friday
Day5_15-18 (Afternoon)	0	0	3	2	0	0	0	0	1	0	0	0	0	0	0	0	1	Researcher	6/13/2025	Friday
Day6_09-12 (Morning)	3	0	2	0	1	2	0	0	0	0	0	0	0	1	0	0	0	Librarian	6/17/2025	Tuesday
Day6_12-15 (Midday)	2	0	1	0	0	2	0	0	0	0	0	0	0	1	0	0	0	Librarian	6/17/2025	Tuesday
Day6_15-18 (Afternoon)	3	5	1	1	0	2	0	0	0	0	2	0	0	0	0	0	0	Librarian	6/17/2025	Tuesday
Day7_09-12 (Morning)	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	Librarian	6/18/2025	Wednesday
Day7_12-15 (Midday)	0	2	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	Librarian	6/18/2025	Wednesday
Day7_15-18 (Afternoon)	0	2	2	1	0	0	0	0	0	0	0	0	0	0	0	0	0	Librarian	6/18/2025	Wednesday

Sum value Day1	4	9	6	9	3	4	6	9	4	1	2	3	0	4	1	2	0
Sum value Day2	4	0	7	0	1	2	3	0	2	0	3	1	0	2	0	0	0
Sum value Day3	3	4	5	1	0	3	0	1	4	3	5	1	0	2	0	1	0
Sum value Day4	4	4	6	7	7	9	3	4	5	0	7	2	1	1	0	1	1
Sum value Day5	2	0	6	3	0	0	0	0	1	0	1	1	0	2	0	0	4
Sum value Day6	8	5	4	1	1	6	0	0	0	0	2	0	0	2	0	0	0
Sum value Day7	0	4	4	1	0	0	0	0	0	0	2	0	0	0	0	0	0
Sum value all days	25	26	38	22	12	24	12	14	16	4	22	8	1	13	1	4	5
Average Occupancy Counts	6	4	6	4	3	5	3	4	4	1	4	2	0	2	0	1	0
Max average Occupancy Counts	6																
Max count within time ranges	8																

Sum value for mornings	7	0	3	2	1	2	0	2	0	0	3	1	0	4	0	0	1
sum value for middays	3	5	11	7	4	4	2	3	0	0	6	3	1	6	1	3	2
sum values for afternoons	15	21	24	13	7	18	10	9	16	4	13	4	0	3	0	1	2

Occupancy Time (Minutes)	Points																			
Days_Times	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	Observer	Date	Day
Day1_09-12 (Morning)	0	0	0	15	0	0	0	120	0	0	0	0	0	5	0	0	0	Researcher	6/9/2025	Monday
Day1_09-12 (Morning)	0	0	0	15	0	0	0	120	0	0	0	0	0	0	0	0	0	Researcher	6/9/2025	Monday
Day1_09-12 (Morning)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	Researcher	6/9/2025	Monday
Day1_09-12 (Morning)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	Researcher	6/9/2025	Monday
Day1_09-12 (Morning)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	Researcher	6/9/2025	Monday
Day1_09-12 (Morning)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	Researcher	6/9/2025	Monday
Day1_09-12 (Morning)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	Researcher	6/9/2025	Monday
Day1_09-12 (Morning)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	Researcher	6/9/2025	Monday
Day1_12-15 (Midday)	0	10	0	120	0	0	10	10	0	0	0	10	0	120	30	30	0	Researcher	6/9/2025	Monday
Day1_12-15 (Midday)	0	0	0	120	0	0	10	10	0	0	0	0	0	0	0	0	0	Researcher	6/9/2025	Monday
Day1_12-15 (Midday)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	Researcher	6/9/2025	Monday
Day1_12-15 (Midday)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	Researcher	6/9/2025	Monday
Day1_12-15 (Midday)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	Researcher	6/9/2025	Monday
Day1_12-15 (Midday)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	Researcher	6/9/2025	Monday
Day1_12-15 (Midday)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	Researcher	6/9/2025	Monday
Day1_12-15 (Midday)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	Researcher	6/9/2025	Monday
Day1_15-18 (Afternoon)	120	30	120	10	20	10	5	10	30	5	90	5	0	60	0	120	0	Researcher	6/9/2025	Monday
Day1_15-18 (Afternoon)	120	30	120	120	20	30	30	10	30	0	90	120	0	60	0	0	0	Researcher	6/9/2025	Monday
Day1_15-18 (Afternoon)	120	30	60	120	20	30	30	60	90	0	0	0	0	0	0	0	0	Researcher	6/9/2025	Monday
Day1_15-18 (Afternoon)	0	30	60	120	0	30	30	60	90	0	0	0	0	0	0	0	0	Researcher	6/9/2025	Monday
Day1_15-18 (Afternoon)	0	40	60	120	0	0	0	60	0	0	0	0	0	0	0	0	0	Researcher	6/9/2025	Monday
Day1_15-18 (Afternoon)	0	40	60	0	0	0	0	0	0	0	0	0	0	0	0	0	0	Researcher	6/9/2025	Monday
Day1_15-18 (Afternoon)	0	40	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	Researcher	6/9/2025	Monday
Day1_15-18 (Afternoon)	0	5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	Researcher	6/9/2025	Monday
Day2_09-12 (Morning)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	Librarian	6/10/2025	Tuesday
Day2_09-12 (Morning)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	Librarian	6/10/2025	Tuesday
Day2_09-12 (Morning)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	Librarian	6/10/2025	Tuesday
Day2_09-12 (Morning)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	Librarian	6/10/2025	Tuesday
Day2_09-12 (Morning)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	Librarian	6/10/2025	Tuesday
Day2_09-12 (Morning)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	Librarian	6/10/2025	Tuesday
Day2_09-12 (Morning)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	Librarian	6/10/2025	Tuesday
Day2_09-12 (Morning)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	Librarian	6/10/2025	Tuesday
Day2_12-15 (Midday)	30	0	30	0	10	0	0	0	0	0	0	0	0	30	0	0	0	Librarian	6/10/2025	Tuesday
Day2_12-15 (Midday)	0	0	30	0	0	0	0	0	0	0	0	0	0	30	0	0	0	Librarian	6/10/2025	Tuesday
Day2_12-15 (Midday)	0	0	30	0	0	0	0	0	0	0	0	0	0	0	0	0	0	Librarian	6/10/2025	Tuesday
Day2_12-15 (Midday)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	Librarian	6/10/2025	Tuesday
Day2_12-15 (Midday)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	Librarian	6/10/2025	Tuesday
Day2_12-15 (Midday)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	Librarian	6/10/2025	Tuesday
Day2_12-15 (Midday)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	Librarian	6/10/2025	Tuesday
Day2_12-15 (Midday)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	Librarian	6/10/2025	Tuesday
Day2_15-18 (Afternoon)	30	0	30	0	0	45	20	0	60	0	40	10	0	0	0	0	0	Librarian	6/10/2025	Tuesday
Day2_15-18 (Afternoon)	30	0	30	0	0	45	20	0	60	0	40	0	0	0	0	0	0	Librarian	6/10/2025	Tuesday
Day2_15-18 (Afternoon)	30	0	30	0	0	0	20	0	0	0	40	0	0	0	0	0	0	Librarian	6/10/2025	Tuesday
Day2_15-18 (Afternoon)	0	0	30	0	0	0	0	0	0	0	0	0	0	0	0	0	0	Librarian	6/10/2025	Tuesday
Day2_15-18 (Afternoon)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	Librarian	6/10/2025	Tuesday
Day2_15-18 (Afternoon)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	Librarian	6/10/2025	Tuesday
Day2_15-18 (Afternoon)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	Librarian	6/10/2025	Tuesday

Day2_15-18 (Afternoon)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	Librarian	6/10/2025	Tuesday
Day3_09-12 (Morning)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	Researcher	6/11/2025	Wednesday
Day3_09-12 (Morning)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	Researcher	6/11/2025	Wednesday
Day3_09-12 (Morning)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	Researcher	6/11/2025	Wednesday
Day3_09-12 (Morning)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	Researcher	6/11/2025	Wednesday
Day3_09-12 (Morning)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	Researcher	6/11/2025	Wednesday
Day3_09-12 (Morning)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	Researcher	6/11/2025	Wednesday
Day3_09-12 (Morning)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	Researcher	6/11/2025	Wednesday
Day3_09-12 (Morning)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	Researcher	6/11/2025	Wednesday
Day3_12-15 (Midday)	0	10	30	30	0	0	0	0	0	0	20	0	0	60	0	150	0	Researcher	6/11/2025	Wednesday
Day3_12-15 (Midday)	0	10	60	0	0	0	0	0	0	0	0	0	0	0	0	0	0	Researcher	6/11/2025	Wednesday
Day3_12-15 (Midday)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	Researcher	6/11/2025	Wednesday
Day3_12-15 (Midday)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	Researcher	6/11/2025	Wednesday
Day3_12-15 (Midday)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	Researcher	6/11/2025	Wednesday
Day3_12-15 (Midday)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	Researcher	6/11/2025	Wednesday
Day3_12-15 (Midday)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	Researcher	6/11/2025	Wednesday
Day3_12-15 (Midday)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	Researcher	6/11/2025	Wednesday
Day3_15-18 (Afternoon)	60	60	10	0	0	5	0	20	20	10	30	30	0	60	0	0	0	Researcher	6/11/2025	Wednesday
Day3_15-18 (Afternoon)	60	60	60	0	0	5	0	0	20	10	30	0	0	0	0	0	0	Researcher	6/11/2025	Wednesday
Day3_15-18 (Afternoon)	60	0	60	0	0	5	0	0	20	10	30	0	0	0	0	0	0	Researcher	6/11/2025	Wednesday
Day3_15-18 (Afternoon)	0	0	0	0	0	0	0	0	20	0	30	0	0	0	0	0	0	Researcher	6/11/2025	Wednesday
Day3_15-18 (Afternoon)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	Researcher	6/11/2025	Wednesday
Day3_15-18 (Afternoon)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	Researcher	6/11/2025	Wednesday
Day3_15-18 (Afternoon)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	Researcher	6/11/2025	Wednesday
Day3_15-18 (Afternoon)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	Researcher	6/11/2025	Wednesday
Day4_09-12 (Morning)	150	0	0	0	0	0	0	0	0	0	10	10	0	30	0	0	0	Researcher	6/12/2025	Thursday
Day4_09-12 (Morning)	150	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	Researcher	6/12/2025	Thursday
Day4_09-12 (Morning)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	Researcher	6/12/2025	Thursday
Day4_09-12 (Morning)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	Researcher	6/12/2025	Thursday
Day4_09-12 (Morning)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	Researcher	6/12/2025	Thursday
Day4_09-12 (Morning)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	Researcher	6/12/2025	Thursday
Day4_09-12 (Morning)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	Researcher	6/12/2025	Thursday
Day4_09-12 (Morning)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	Researcher	6/12/2025	Thursday
Day4_12-15 (Midday)	0	0	45	10	10	30	0	30	0	0	90	10	5	0	0	15	0	Researcher	6/12/2025	Thursday
Day4_12-15 (Midday)	0	0	0	60	10	30	0	0	0	0	90	0	0	0	0	0	0	Researcher	6/12/2025	Thursday
Day4_12-15 (Midday)	0	0	0	60	10	0	0	0	0	0	60	0	0	0	0	0	0	Researcher	6/12/2025	Thursday
Day4_12-15 (Midday)	0	0	0	0	0	0	0	0	0	0	10	0	0	0	0	0	0	Researcher	6/12/2025	Thursday
Day4_12-15 (Midday)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	Researcher	6/12/2025	Thursday
Day4_12-15 (Midday)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	Researcher	6/12/2025	Thursday
Day4_12-15 (Midday)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	Researcher	6/12/2025	Thursday
Day4_12-15 (Midday)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	Researcher	6/12/2025	Thursday
Day4_15-18 (Afternoon)	90	15	60	60	90	10	60	120	60	0	45	0	0	0	0	0	60	Researcher	6/12/2025	Thursday
Day4_15-18 (Afternoon)	90	15	60	60	90	10	60	60	60	0	60	0	0	0	0	0	0	Researcher	6/12/2025	Thursday
Day4_15-18 (Afternoon)	0	30	90	60	30	10	30	60	30	0	0	0	0	0	0	0	0	Researcher	6/12/2025	Thursday
Day4_15-18 (Afternoon)	0	30	90	60	30	10	0	0	30	0	0	0	0	0	0	0	0	Researcher	6/12/2025	Thursday
Day4_15-18 (Afternoon)	0	0	90	0	0	120	0	0	30	0	0	0	0	0	0	0	0	Researcher	6/12/2025	Thursday
Day4_15-18 (Afternoon)	0	0	0	0	0	120	0	0	0	0	0	0	0	0	0	0	0	Researcher	6/12/2025	Thursday
Day4_15-18 (Afternoon)	0	0	0	0	0	120	0	0	0	0	0	0	0	0	0	0	0	Researcher	6/12/2025	Thursday
Day4_15-18 (Afternoon)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	Researcher	6/12/2025	Thursday
Day5_09-12 (Morning)	30	0	30	0	0	0	0	0	0	0	0	0	0	60	0	0	90	Researcher	6/13/2025	Friday
Day5_09-12 (Morning)	60	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	Researcher	6/13/2025	Friday

Day5_09-12 (Morning)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	Researcher	6/13/2025	Friday
Day5_09-12 (Morning)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	Researcher	6/13/2025	Friday
Day5_09-12 (Morning)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	Researcher	6/13/2025	Friday
Day5_09-12 (Morning)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	Researcher	6/13/2025	Friday
Day5_09-12 (Morning)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	Researcher	6/13/2025	Friday
Day5_09-12 (Morning)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	Researcher	6/13/2025	Friday
Day5_12-15 (Midday)	0	0	10	10	0	0	0	0	10	0	5	20	0	60	0	0	20	Researcher	6/13/2025	Friday
Day5_12-15 (Midday)	0	0	10	0	0	0	0	0	0	0	0	0	0	0	0	0	20	Researcher	6/13/2025	Friday
Day5_12-15 (Midday)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	Researcher	6/13/2025	Friday
Day5_12-15 (Midday)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	Researcher	6/13/2025	Friday
Day5_12-15 (Midday)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	Researcher	6/13/2025	Friday
Day5_12-15 (Midday)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	Researcher	6/13/2025	Friday
Day5_12-15 (Midday)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	Researcher	6/13/2025	Friday
Day5_12-15 (Midday)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	Researcher	6/13/2025	Friday
Day5_15-18 (Afternoon)	0	0	15	15	0	0	0	0	0	0	0	0	0	0	0	0	10	Researcher	6/13/2025	Friday
Day5_15-18 (Afternoon)	0	0	15	60	0	0	0	0	0	0	0	0	0	0	0	0	0	Researcher	6/13/2025	Friday
Day5_15-18 (Afternoon)	0	0	60	0	0	0	0	0	0	0	0	0	0	0	0	0	0	Researcher	6/13/2025	Friday
Day5_15-18 (Afternoon)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	Researcher	6/13/2025	Friday
Day5_15-18 (Afternoon)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	Researcher	6/13/2025	Friday
Day5_15-18 (Afternoon)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	Researcher	6/13/2025	Friday
Day5_15-18 (Afternoon)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	Researcher	6/13/2025	Friday
Day5_15-18 (Afternoon)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	Researcher	6/13/2025	Friday
Day6_09-12 (Morning)	30	0	30	0	90	45	0	0	0	0	0	0	0	60	0	0	0	Librarian	6/17/2025	Tuesday
Day6_09-12 (Morning)	30	0	30	0	0	45	0	0	0	0	0	0	0	0	0	0	0	Librarian	6/17/2025	Tuesday
Day6_09-12 (Morning)	60	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	Librarian	6/17/2025	Tuesday
Day6_09-12 (Morning)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	Librarian	6/17/2025	Tuesday
Day6_09-12 (Morning)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	Librarian	6/17/2025	Tuesday
Day6_09-12 (Morning)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	Librarian	6/17/2025	Tuesday
Day6_09-12 (Morning)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	Librarian	6/17/2025	Tuesday
Day6_09-12 (Morning)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	Librarian	6/17/2025	Tuesday
Day6_12-15 (Midday)	30	0	30	0	0	5	0	0	0	0	0	0	0	120	0	0	0	Librarian	6/17/2025	Tuesday
Day6_12-15 (Midday)	30	0	0	0	0	5	0	0	0	0	0	0	0	0	0	0	0	Librarian	6/17/2025	Tuesday
Day6_12-15 (Midday)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	Librarian	6/17/2025	Tuesday
Day6_12-15 (Midday)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	Librarian	6/17/2025	Tuesday
Day6_12-15 (Midday)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	Librarian	6/17/2025	Tuesday
Day6_12-15 (Midday)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	Librarian	6/17/2025	Tuesday
Day6_12-15 (Midday)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	Librarian	6/17/2025	Tuesday
Day6_12-15 (Midday)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	Librarian	6/17/2025	Tuesday
Day6_15-18 (Afternoon)	30	40	30	30	0	80	0	0	0	0	120	0	0	0	0	0	0	Librarian	6/17/2025	Tuesday
Day6_15-18 (Afternoon)	30	40	0	0	0	80	0	0	0	0	120	0	0	0	0	0	0	Librarian	6/17/2025	Tuesday
Day6_15-18 (Afternoon)	60	25	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	Librarian	6/17/2025	Tuesday
Day6_15-18 (Afternoon)	0	25	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	Librarian	6/17/2025	Tuesday
Day6_15-18 (Afternoon)	0	25	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	Librarian	6/17/2025	Tuesday
Day6_15-18 (Afternoon)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	Librarian	6/17/2025	Tuesday
Day6_15-18 (Afternoon)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	Librarian	6/17/2025	Tuesday
Day6_15-18 (Afternoon)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	Librarian	6/17/2025	Tuesday
Day7_09-12 (Morning)	0	0	0	0	0	0	0	0	0	0	35	0	0	0	0	0	0	Librarian	6/18/2025	Wednesday
Day7_09-12 (Morning)	0	0	0	0	0	0	0	0	0	0	35	0	0	0	0	0	0	Librarian	6/18/2025	Wednesday
Day7_09-12 (Morning)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	Librarian	6/18/2025	Wednesday
Day7_09-12 (Morning)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	Librarian	6/18/2025	Wednesday
Day7_09-12 (Morning)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	Librarian	6/18/2025	Wednesday

Day7_09-12 (Morning)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	Librarian	6/18/2025 Wednesday
Day7_09-12 (Morning)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	Librarian	6/18/2025 Wednesday
Day7_09-12 (Morning)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	Librarian	6/18/2025 Wednesday
Day7_12-15 (Midday)	0	30	30	0	0	0	0	0	0	0	0	0	0	0	0	0	0	Librarian	6/18/2025 Wednesday
Day7_12-15 (Midday)	0	30	30	0	0	0	0	0	0	0	0	0	0	0	0	0	0	Librarian	6/18/2025 Wednesday
Day7_12-15 (Midday)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	Librarian	6/18/2025 Wednesday
Day7_12-15 (Midday)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	Librarian	6/18/2025 Wednesday
Day7_12-15 (Midday)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	Librarian	6/18/2025 Wednesday
Day7_12-15 (Midday)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	Librarian	6/18/2025 Wednesday
Day7_12-15 (Midday)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	Librarian	6/18/2025 Wednesday
Day7_12-15 (Midday)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	Librarian	6/18/2025 Wednesday
Day7_15-18 (Afternoon)	0	60	30	5	0	0	0	0	0	0	0	0	0	0	0	0	0	Librarian	6/18/2025 Wednesday
Day7_15-18 (Afternoon)	0	60	30	0	0	0	0	0	0	0	0	0	0	0	0	0	0	Librarian	6/18/2025 Wednesday
Day7_15-18 (Afternoon)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	Librarian	6/18/2025 Wednesday
Day7_15-18 (Afternoon)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	Librarian	6/18/2025 Wednesday
Day7_15-18 (Afternoon)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	Librarian	6/18/2025 Wednesday
Day7_15-18 (Afternoon)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	Librarian	6/18/2025 Wednesday
Day7_15-18 (Afternoon)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	Librarian	6/18/2025 Wednesday
Day7_15-18 (Afternoon)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	Librarian	6/18/2025 Wednesday

Sum value Day1	360	255	480	760	60	100	115	460	240	5	180	135	0	245	30	150	0
Sum value Day2	120	0	210	0	10	90	60	0	120	0	120	10	0	60	0	0	0
Sum value Day3	180	140	220	30	0	15	0	20	80	30	140	30	0	120	0	150	0
Sum value Day4	480	90	435	370	270	460	150	270	210	0	365	20	5	30	0	15	60
Sum value Day5	90	0	140	85	0	0	0	0	10	0	5	20	0	120	0	140	140
Sum value Day6	300	155	120	30	90	260	0	0	0	0	240	0	0	180	0	0	0
Sum value Day7	0	180	120	5	0	0	0	0	0	0	70	0	0	0	0	0	0

Sum value for mornings	510	0	90	30	90	90	0	240	0	0	80	10	0	155	0	0	90
sum value for middays	90	90	335	410	40	70	20	50	10	0	275	40	5	420	30	235	0
sum values for afternoons	930	730	1300	840	300	765	305	460	650	35	765	165	0	180	0	130	60

Average time spent	9	5	10	8	3	6	2	4	4	0	7	1	0	4	0	2	1

Max time withing time ranges	150
Max average time spent	10
Max Average occupancy efficacy	64

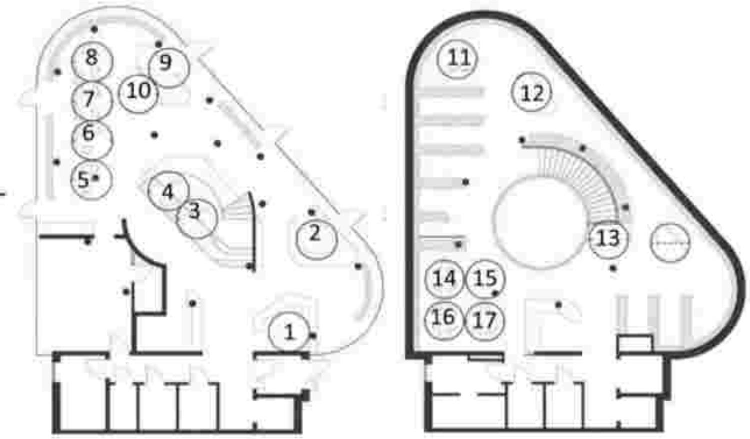
	Points																
occupancy data	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
Utilization score	57	21	62	32	7	25	6	16	15	0	28	2	0	10	0	2	0
Normalized efficacy	0.9	0.3	1.0	0.5	0.1	0.4	0.1	0.2	0.2	0.0	0.4	0.0	0.0	0.2	0.0	0.0	0.0
Balanced efficacy	1.76	1.34	1.80	1.52	0.91	1.41	0.83	1.22	1.20	0.08	1.47	0.51	0.00	1.05	0.02	0.46	0.11
BE-Bemin	1.76	1.33	1.79	1.52	0.90	1.41	0.83	1.22	1.19	0.08	1.46	0.51	0.00	1.04	0.02	0.46	0.11
Balanced relative efficacy	0.9812	0.7439	1.0000	0.8477	0.5029	0.7851	0.4625	0.6789	0.6655	0.0440	0.8164	0.2829	0.0000	0.5813	0.0088	0.2539	0.0613

BE max	1.80
BE min	0.00
BEmax-BEmin	1.79

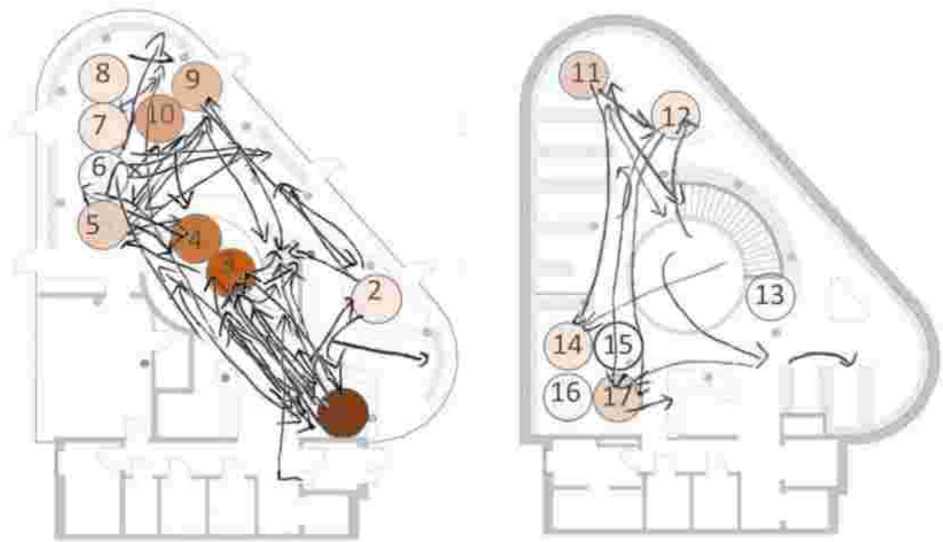
Balanced Efficacy (Balanced Utilization score)=
BE = Log (1 + (Average Occupancy Counts × Average Time Spent))

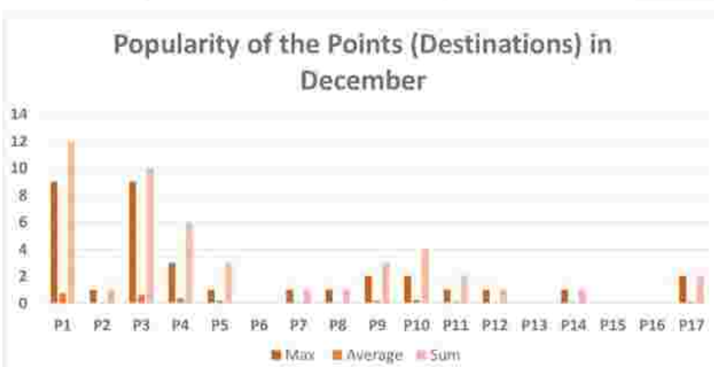
$$\textbf{Balanced Relative Efficacy} = \frac{\textbf{BE - BEmin}}{\textbf{BEmax - BEmin}}$$

(time-specific)



APPENDIX 5.1 – Observation Sheet of Movement Intensity for Maly Kack in December



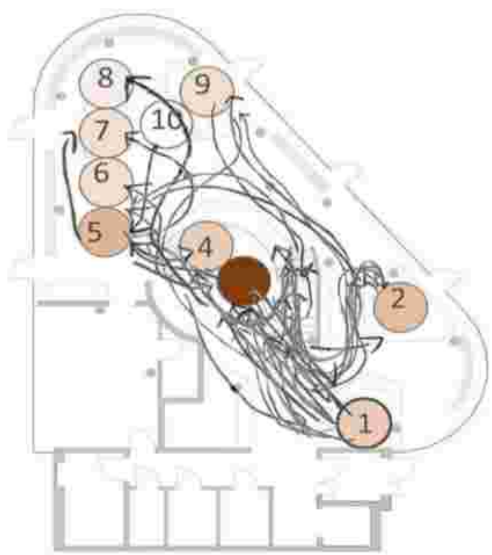


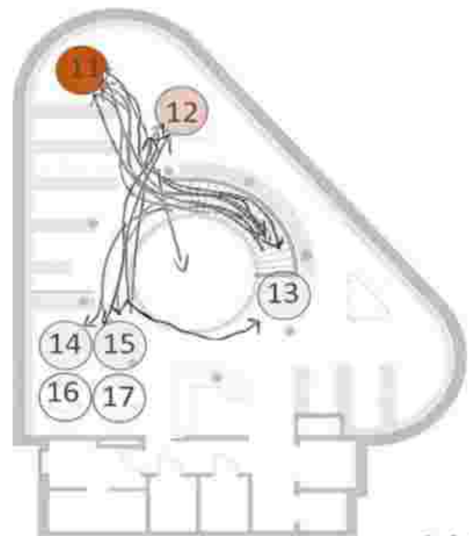
Origin-Destination Matrix

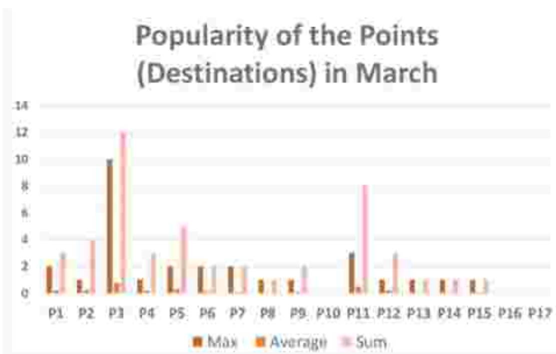
Points	P1	P2	P3	P4	P5	P6	P7	P8	P9	P10	P11	P12	P13	P14	P15	P16	P17
P1	N/A	1	9	2	0	0	0	0	0	0	1	0	0	0	0	0	0
P2	1	N/A	1	0	0	0	0	1	2	0	1	0	0	0	0	0	0
P3	9	0	N/A	0	1	0	0	0	0	0	0	0	0	0	0	0	0
P4	2	0	0	N/A	1	0	0	0	0	0	0	0	0	0	0	0	0
P5	0	0	0	3	N/A	0	0	0	0	1	0	0	0	0	0	0	0
P6	0	0	0	0	0	N/A	0	0	0	2	0	0	0	0	0	0	0
P7	0	0	0	0	0	0	N/A	0	0	1	0	0	0	0	0	0	0
P8	0	0	0	0	0	0	0	N/A	1	0	0	0	0	0	0	0	0
P9	0	0	0	0	0	0	0	0	N/A	0	0	0	0	0	0	0	0
P10	0	0	0	1	1	0	1	0	0	N/A	0	0	0	0	0	0	0
P11	0	0	0	0	0	0	0	0	0	0	N/A	1	0	1	0	0	0
P12	0	0	0	0	0	0	0	0	0	0	0	N/A	0	0	0	0	2
P13	0	0	0	0	0	0	0	0	0	0	0	0	N/A	0	0	0	0
P14	0	0	0	0	0	0	0	0	0	0	0	0	0	N/A	0	0	0
P15	0	0	0	0	0	0	0	0	0	0	0	0	0	0	N/A	0	0
P16	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	N/A	0
P17	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	N/A

Points	P1	P2	P3	P4	P5	P6	P7	P8	P9	P10	P11	P12	P13	P14	P15	P16	P17
Max	9	1	9	3	1	0	1	1	2	2	1	1	0	1	0	0	2
Average	0.75	0.0625	0.625	0.375	0.1875	0	0.0625	0.0625	0.1875	0.25	0.125	0.0625	0	0.0625	0	0	0.125
Sum	12	1	10	6	3	0	1	1	3	4	2	1	0	1	0	0	2

APPENDIX 5.1 – Observation Sheet of Movement Intensity for Maly Kack in March





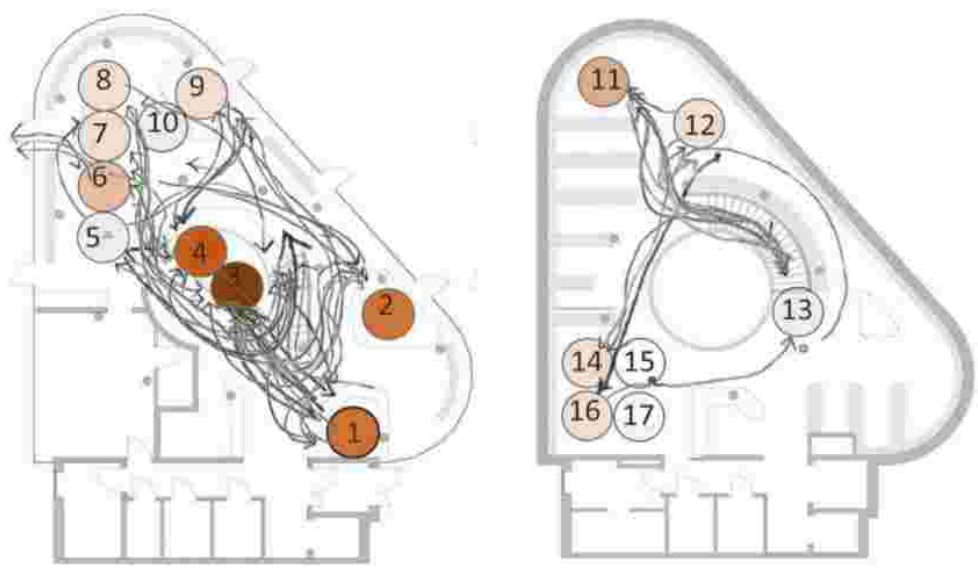


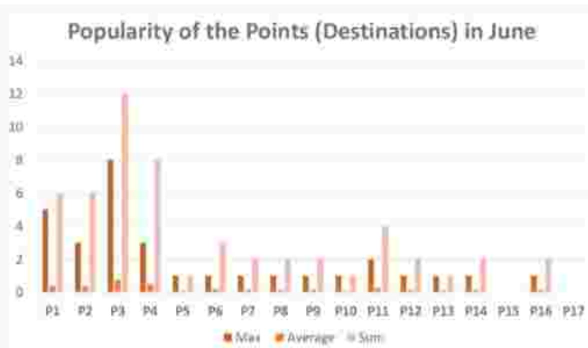
Origin-Destination Matirx

[illegible]	P1	P2	P3	P4	P5	P6	P7	P8	P9	P10	P11	P12	P13	P14	P15	P16	P17
P1	N/A	0	10	1	1	0	0	0	0	0	1	0	0	0	0	0	0
P2	0	N/A	0	0	0	0	0	0	0	0	3	0	0	0	0	0	0
P3	2	1	N/A	0	2	0	0	1	0	0	1	1	0	0	1	0	0
P4	1	0	0	N/A	0	2	0	0	0	0	0	0	0	0	0	0	0
P5	0	1	2	1	N/A	0	2	0	0	0	0	0	0	0	0	0	0
P6	0	0	0	0	0	N/A	0	0	0	0	0	0	0	0	0	0	0
P7	0	0	0	0	0	0	N/A	0	0	0	0	0	0	0	0	0	0
P8	0	0	0	0	0	0	0	N/A	0	0	0	0	0	0	0	0	0
P9	0	0	0	0	0	0	0	0	N/A	0	2	0	0	0	0	0	0
P10	0	0	0	0	1	0	0	0	0	N/A	0	0	0	0	0	0	0
P11	0	1	0	1	1	0	0	0	1	0	N/A	0	0	0	0	0	0
P12	0	0	0	0	0	0	0	0	0	0	1	N/A	1	1	0	0	0
P13	0	0	0	0	0	0	0	0	0	0	0	1	N/A	0	0	0	0
P14	0	0	0	0	0	0	0	0	0	0	0	0	0	N/A	0	0	0
P15	0	1	0	0	0	0	0	0	1	0	0	1	0	0	N/A	0	0
P16	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	N/A	0
P17	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	N/A

[illegible]	P1	P2	P3	P4	P5	P6	P7	P8	P9	P10	P11	P12	P13	P14	P15	P16	P17
Max	2	1	10	1	2	2	2	1	1	0	3	1	1	1	1	0	0
Average	0.19	0.25	0.75	0.19	0.31	0.13	0.13	0.06	0.13	0.00	0.50	0.19	0.06	0.06	0.06	0.00	0.00
Sum	3	4	12	3	5	2	2	1	2	0	8	3	1	1	1	0	0

APPENDIX 5.1 – Observation Sheet of Movement Intensity for Maly Kack in June





Origin-Destination Matirx

[illegible]	P1	P2	P3	P4	P5	P6	P7	P8	P9	P10	P11	P12	P13	P14	P15	P16	P17
P1	N/A	1	8	0	0	0	0	0	0	0	1	1	0	0	0	1	0
P2	1	N/A	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0
P3	5	3	N/A	0	0	1	0	0	1	0	0	0	0	0	0	0	0
P4	0	1	0	N/A	0	1	1	1	0	0	0	0	0	0	0	0	0
P5	0	0	0	0	N/A	0	1	0	1	0	0	1	0	0	0	0	0
P6	0	1	2	0	0	N/A	0	0	0	0	0	0	0	0	0	0	0
P7	0	0	0	2	0	0	N/A	0	0	0	0	0	0	0	0	0	0
P8	0	0	0	3	0	0	0	N/A	0	0	1	0	0	0	0	0	0
P9	0	0	1	1	0	0	0	0	N/A	1	0	0	0	0	0	0	0
P10	0	0	0	0	0	0	0	1	0	N/A	0	0	0	0	0	0	0
P11	0	0	0	0	0	1	0	0	0	0	N/A	0	0	1	0	0	0
P12	0	0	1	0	0	0	0	0	0	0	2	N/A	0	0	0	1	0
P13	0	0	0	0	1	0	0	0	0	0	0	0	N/A	0	0	0	0
P14	0	0	0	3	0	0	0	0	0	0	0	0	0	N/A	0	0	0
P15	0	0	0	0	0	0	0	0	0	0	0	0	0	1	N/A	0	0
P16	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	N/A	0
P17	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	N/A

[illegible]	P1	P2	P3	P4	P5	P6	P7	P8	P9	P10	P11	P12	P13	P14	P15	P16	P17
Max	5	3	8	3	1	1	1	1	1	1	2	1	1	1	0	1	0
Average	0.375	0.375	0.75	0.5	0.0625	0.1875	0.125	0.125	0.125	0.0625	0.25	0.125	0.0625	0.125	0	0.125	0
Sum	6	6	12	8	1	3	2	2	2	1	4	2	1	2	0	2	0

APPENDIX 5.2 – Observation Sheet for Witomino in December

Occupancy Counts	Points																							
Days_Times	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	Observer	Date	Day
Day1_09-12 (Morning)	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	Researcher	9/12/2024	Monday
Day1_12-15 (Midday)	1	0	2	0	0	2	0	2	1	0	2	2	2	0	0	0	0	0	1	2	0	Researcher	9/12/2024	Monday
Day1_15-18 (Afternoon)	0	0	2	0	0	0	0	0	0	0	1	2	0	0	0	0	0	0	1	0	0	Researcher	9/12/2024	Monday
Day2_09-12 (Morning)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	Librarian	10/12/2024	Tuesday
Day2_12-15 (Midday)	0	0	0	0	0	2	0	0	0	0	1	1	0	0	0	0	1	0	0	1	0	Librarian	10/12/2024	Tuesday
Day2_15-18 (Afternoon)	0	0	0	0	0	0	0	2	0	0	2	1	2	0	0	0	0	0	0	2	3	Librarian	10/12/2024	Tuesday
Day3_09-12 (Morning)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	Librarian	11/12/2024	Wednesday
Day3_12-15 (Midday)	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0	0	0	2	1	Librarian	11/12/2024	Wednesday
Day3_15-18 (Afternoon)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	Librarian	11/12/2024	Wednesday
Day4_09-12 (Morning)	0	0	0	0	0	2	0	2	0	0	2	2	0	1	0	0	0	0	0	0	0	Librarian	12/12/2024	Thursday
Day4_12-15 (Midday)	0	0	0	0	0	0	1	3	0	0	1	2	2	0	0	0	0	0	0	1	0	Librarian	12/12/2024	Thursday
Day4_15-18 (Afternoon)	0	0	0	0	0	0	1	2	0	0	0	1	0	0	0	0	0	0	1	1	0	Librarian	12/12/2024	Thursday
Day5_09-12 (Morning)	2	0	0	0	0	0	0	0	1	4	1	4	2	0	0	3	0	3	0	3	3	Researcher	13/12/2024	Friday
Day5_12-15 (Midday)	1	0	0	0	0	0	0	2	0	3	3	5	0	0	0	2	2	4	4	2	2	Researcher	13/12/2024	Friday
Day5_15-18 (Afternoon)	0	0	0	0	0	0	0	0	0	2	0	2	0	0	0	0	0	0	0	2	0	Researcher	13/12/2024	Friday

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21
Sum value Day1	4	0	4	0	0	2	0	2	1	0	3	4	2	0	0	0	0	0	2	2	0
Sum value Day2	0	0	0	0	0	2	0	2	0	0	3	2	2	0	0	0	1	0	0	3	3
Sum value Day3	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0	0	0	2	1
Sum value Day4	0	0	0	0	0	2	2	7	0	0	3	5	2	1	0	0	0	0	1	2	0
Sum value Day5	3	0	0	0	0	0	0	2	1	9	4	12	2	0	0	5	2	7	4	7	5
Sum value all days	7	0	4	0	0	6	2	13	2	9	14	24	8	1	0	5	3	7	7	16	9
Average Occupancy Counts	2	0	1	0	0	2	1	4	1	3	5	8	3	0	0	2	1	2	2	5	2
Max average Occupancy Counts	8																				
Max count within time ranges	6																				

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21
Sum value for mornings	5	0	0	0	0	2	0	2	1	4	3	6	2	1	0	3	0	3	0	3	3
sum value for middays	2	0	2	0	0	4	1	7	1	3	8	12	4	0	0	2	3	4	5	8	3
sum values for afternoons	0	0	2	0	0	0	1	4	0	2	3	6	2	0	0	0	0	0	2	5	3

Occupancy Time (Minutes)	Points																							
Days_Times	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	Observer	Date	Day
Day1_09-12 (Morning)	10	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	Researcher	9/12/2024	Monday
Day1_09-12 (Morning)	30	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	Researcher	9/12/2024	Monday
Day1_09-12 (Morning)	30	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	Researcher	9/12/2024	Monday
Day1_09-12 (Morning)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	Researcher	9/12/2024	Monday
Day1_09-12 (Morning)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	Researcher	9/12/2024	Monday
Day1_09-12 (Morning)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	Researcher	9/12/2024	Monday
Day1_12-15 (Midday)	20	0	60	0	0	10	0	90	5	0	60	60	90	0	0	0	0	0	30	60	0	Researcher	9/12/2024	Monday
Day1_12-15 (Midday)	0	0	60	0	0	10	0	90	0	0	60	60	90	0	0	0	0	0	0	60	0	Researcher	9/12/2024	Monday
Day1_12-15 (Midday)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	Researcher	9/12/2024	Monday
Day1_12-15 (Midday)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	Researcher	9/12/2024	Monday
Day1_12-15 (Midday)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	Researcher	9/12/2024	Monday
Day1_12-15 (Midday)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	Researcher	9/12/2024	Monday
Day1_15-18 (Afternoon)	0	0	30	0	0	0	0	0	0	0	60	30	0	0	0	0	0	0	60	0	0	Researcher	9/12/2024	Monday
Day1_15-18 (Afternoon)	0	0	30	0	0	0	0	0	0	0	0	30	0	0	0	0	0	0	0	0	0	Researcher	9/12/2024	Monday
Day1_15-18 (Afternoon)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	Researcher	9/12/2024	Monday
Day1_15-18 (Afternoon)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	Researcher	9/12/2024	Monday
Day1_15-18 (Afternoon)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	Researcher	9/12/2024	Monday
Day1_15-18 (Afternoon)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	Researcher	9/12/2024	Monday
Day2_09-12 (Morning)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	Librarian	10/12/2024	Tuesday
Day2_09-12 (Morning)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	Librarian	10/12/2024	Tuesday
Day2_09-12 (Morning)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	Librarian	10/12/2024	Tuesday

Day2_09-12 (Morning)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	Librarian	10/12/2024	Tuesday
Day2_09-12 (Morning)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	Librarian	10/12/2024	Tuesday
Day2_09-12 (Morning)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	Librarian	10/12/2024	Tuesday
Day2_12-15 (Midday)	0	0	0	0	0	90	0	0	0	0	120	0	0	0	0	0	120	0	0	60	0	Librarian	10/12/2024	Tuesday
Day2_12-15 (Midday)	0	0	0	0	0	90	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	Librarian	10/12/2024	Tuesday
Day2_12-15 (Midday)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	Librarian	10/12/2024	Tuesday
Day2_12-15 (Midday)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	Librarian	10/12/2024	Tuesday
Day2_12-15 (Midday)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	Librarian	10/12/2024	Tuesday
Day2_12-15 (Midday)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	Librarian	10/12/2024	Tuesday
Day2_15-18 (Afternoon)	0	0	0	0	0	0	0	30	0	0	180	180	120	0	0	0	0	0	0	120	120	Librarian	10/12/2024	Tuesday
Day2_15-18 (Afternoon)	0	0	0	0	0	0	0	30	0	0	180	180	120	0	0	0	0	0	0	120	120	Librarian	10/12/2024	Tuesday
Day2_15-18 (Afternoon)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	120	Librarian	10/12/2024	Tuesday
Day2_15-18 (Afternoon)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	Librarian	10/12/2024	Tuesday
Day2_15-18 (Afternoon)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	Librarian	10/12/2024	Tuesday
Day2_15-18 (Afternoon)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	Librarian	10/12/2024	Tuesday
Day3_09-12 (Morning)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	Librarian	11/12/2024	Wednesday
Day3_09-12 (Morning)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	Librarian	11/12/2024	Wednesday
Day3_09-12 (Morning)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	Librarian	11/12/2024	Wednesday
Day3_09-12 (Morning)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	Librarian	11/12/2024	Wednesday
Day3_09-12 (Morning)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	Librarian	11/12/2024	Wednesday
Day3_09-12 (Morning)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	Librarian	11/12/2024	Wednesday
Day3_12-15 (Midday)	0	0	0	0	0	0	0	0	0	0	120	120	0	0	0	0	0	0	0	120	120	Librarian	11/12/2024	Wednesday
Day3_12-15 (Midday)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	120	0	Librarian	11/12/2024	Wednesday
Day3_12-15 (Midday)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	Librarian	11/12/2024	Wednesday
Day3_12-15 (Midday)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	Librarian	11/12/2024	Wednesday
Day3_12-15 (Midday)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	Librarian	11/12/2024	Wednesday
Day3_12-15 (Midday)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	Librarian	11/12/2024	Wednesday
Day3_15-18 (Afternoon)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	Librarian	11/12/2024	Wednesday
Day3_15-18 (Afternoon)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	Librarian	11/12/2024	Wednesday
Day3_15-18 (Afternoon)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	Librarian	11/12/2024	Wednesday
Day3_15-18 (Afternoon)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	Librarian	11/12/2024	Wednesday
Day3_15-18 (Afternoon)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	Librarian	11/12/2024	Wednesday
Day3_15-18 (Afternoon)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	Librarian	11/12/2024	Wednesday
Day4_09-12 (Morning)	0	0	0	0	0	15	0	20	0	0	30	150	0	15	0	0	0	0	0	0	0	Librarian	12/12/2024	Thursday
Day4_09-12 (Morning)	0	0	0	0	0	15	0	20	0	0	30	150	0	0	0	0	0	0	0	0	0	Librarian	12/12/2024	Thursday
Day4_09-12 (Morning)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	Librarian	12/12/2024	Thursday
Day4_09-12 (Morning)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	Librarian	12/12/2024	Thursday
Day4_09-12 (Morning)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	Librarian	12/12/2024	Thursday
Day4_09-12 (Morning)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	Librarian	12/12/2024	Thursday
Day4_12-15 (Midday)	0	0	0	0	0	0	90	90	0	0	150	150	150	0	0	0	0	0	0	180	0	Librarian	12/12/2024	Thursday
Day4_12-15 (Midday)	0	0	0	0	0	0	0	90	0	0	0	150	150	0	0	0	0	0	0	0	0	Librarian	12/12/2024	Thursday
Day4_12-15 (Midday)	0	0	0	0	0	0	0	90	0	0	0	0	0	0	0	0	0	0	0	0	0	Librarian	12/12/2024	Thursday
Day4_12-15 (Midday)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	Librarian	12/12/2024	Thursday
Day4_12-15 (Midday)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	Librarian	12/12/2024	Thursday
Day4_12-15 (Midday)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	Librarian	12/12/2024	Thursday
Day4_15-18 (Afternoon)	0	0	0	0	0	0	60	120	0	0	0	60	0	0	0	0	0	0	60	120	0	Librarian	12/12/2024	Thursday
Day4_15-18 (Afternoon)	0	0	0	0	0	0	0	120	0	0	0	0	0	0	0	0	0	0	0	0	0	Librarian	12/12/2024	Thursday
Day4_15-18 (Afternoon)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	Librarian	12/12/2024	Thursday
Day4_15-18 (Afternoon)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	Librarian	12/12/2024	Thursday
Day4_15-18 (Afternoon)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	Librarian	12/12/2024	Thursday
Day4_15-18 (Afternoon)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	Librarian	12/12/2024	Thursday
Day5_09-12 (Morning)	20	0	0	0	0	0	0	0	20	20	20	20	20	0	0	20	0	20	0	20	20	Researcher	13/12/2024	Friday
Day5_09-12 (Morning)	20	0	0	0	0	0	0	0	0	20	0	20	20	0	0	20	0	20	0	20	20	Researcher	13/12/2024	Friday
Day5_09-12 (Morning)	0	0	0	0	0	0	0	0	0	20	0	20	0	0	0	20	0	20	0	20	20	Researcher	13/12/2024	Friday
Day5_09-12 (Morning)	0	0	0	0	0	0	0	0	0	20	0	20	0	0	0	0	0	0	0	0	0	Researcher	13/12/2024	Friday
Day5_09-12 (Morning)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	Researcher	13/12/2024	Friday
Day5_09-12 (Morning)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	Researcher	13/12/2024	Friday
Day5_12-15 (Midday)	30	0	0	0	0	0	0	60	0	15	15	15	0	0	0	15	15	15	15	15	15	Researcher	13/15/2024	Friday
Day5_12-15 (Midday)	0	0	0	0	0	0	0	60	0	30	15	15	0	0	0	15	15	15	15	15	15	Researcher	13/15/2024	Friday

Day5_12-15 (Midday)	0	0	0	0	0	0	0	0	0	30	30	15	0	0	0	0	0	15	15	0	0	Researcher	13/15/2024	Friday
Day5_12-15 (Midday)	0	0	0	0	0	0	0	0	0	0	0	15	0	0	0	0	0	15	15	0	0	Researcher	13/15/2024	Friday
Day5_12-15 (Midday)	0	0	0	0	0	0	0	0	0	0	0	30	0	0	0	0	0	0	0	0	0	Researcher	13/15/2024	Friday
Day5_12-15 (Midday)	0	0	0	0	0	0	0	0	0	0	0	30	0	0	0	0	0	0	0	0	0	Researcher	13/15/2024	Friday
Day5_15-18 (Afternoon)	0	0	0	0	0	0	0	0	0	60	0	30	0	0	0	0	0	0	0	60	0	Researcher	13/18/2024	Friday
Day5_15-18 (Afternoon)	0	0	0	0	0	0	0	0	0	60	0	30	0	0	0	0	0	0	0	60	0	Researcher	13/18/2024	Friday
Day5_15-18 (Afternoon)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	Researcher	13/18/2024	Friday
Day5_15-18 (Afternoon)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	Researcher	13/18/2024	Friday
Day5_15-18 (Afternoon)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	Researcher	13/18/2024	Friday
Day5_15-18 (Afternoon)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	Researcher	13/18/2024	Friday

Sum value Day1	90	0	180	0	0	20	0	180	5	0	180	180	180	0	0	0	0	0	90	120	0
Sum value Day2	0	0	0	0	0	180	0	60	0	0	480	360	240	0	0	0	120	0	0	300	360
Sum value Day3	0	0	0	0	0	0	0	0	0	0	120	120	0	0	0	0	0	0	0	240	120
Sum value Day4	0	0	0	0	0	30	150	550	0	0	210	660	300	15	0	0	0	0	60	300	0
Sum value Day5	70	0	0	0	0	0	0	120	20	275	80	260	40	0	0	90	30	120	60	210	90

Sum value for mornings	110	0	0	0	0	30	0	40	20	80	80	380	40	15	0	60	0	60	0	60	60
sum value for middays	50	0	120	0	0	200	90	570	5	75	570	660	480	0	0	30	150	60	90	630	150
sum values for afternoons	0	0	60	0	0	0	60	300	0	120	420	540	240	0	0	0	0	0	120	480	360

Average time spent	2	0	2	0	0	3	2	10	0	3	12	18	8	0	0	1	2	1	2	13	6

Max time withing time ranges	180
Max average time spent	18
Max Average occupancy efficacy	140

	Points																				
occupancy data	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21
Utilization score	4	0	3	0	0	5	1	44	0	9	55	140	23	0	0	2	2	3	5	69	10
Normalized efficacy	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.3	0.0	0.1	0.4	1.0	0.2	0.0	0.0	0.0	0.0	0.0	0.0	0.5	0.1
Balanced efficacy	0.71	0.00	0.56	0.00	0.00	0.79	0.32	1.65	0.07	1.01	1.75	2.15	1.37	0.02	0.00	0.43	0.43	0.61	0.81	1.85	1.02
BE-Bemin	0.71	0.00	0.56	0.00	0.00	0.79	0.32	1.65	0.07	1.01	1.75	2.15	1.37	0.02	0.00	0.43	0.43	0.61	0.81	1.85	1.02
Balanced relative efficacy	0.3309	0	0.2624	0	0	0.3655	0.1509	0.7679	0.0343	0.4683	0.8146	1	0.6377	0.0109	0	0.1981	0.1981	0.2855	0.3763	0.8589	0.4748

BE max	2.15
BE min	0.00
BEmax-BEmin	2.15

Balanced Efficacy (Balanced Utilization score)=
BE = Log (1 + (Average Occupancy Counts × Average Time Spent))

$$\text{Balanced Relative Efficacy (time-specific)} = \frac{BE - BEmin}{BEmax - BEmin}$$

APPENDIX 5.2 – Observation Sheet for Witomino in March

Occupancy Counts	Points																						
Days_Times	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	Observer	Date	Day
Day1_09-12 (Morning)	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	Librarian	11/3/2025	Tuesday
Day1_12-15 (Midday)	0	0	1	0	0	1	1	2	0	1	1	1	0	0	0	0	0	0	0	0	2	Librarian	11/3/2025	Tuesday
Day1_15-18 (Afternoon)	0	0	0	1	0	0	0	0	0	2	0	3	0	0	0	0	0	0	0	1	0	Librarian	11/3/2025	Tuesday
Day2_09-12 (Morning)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	Librarian	12/3/2025	Wednesday
Day2_12-15 (Midday)	1	0	0	0	4	0	0	3	0	2	2	4	0	0	0	0	0	0	2	0	2	Librarian	12/3/2025	Wednesday
Day2_15-18 (Afternoon)	3	0	0	0	0	3	0	2	1	0	0	2	0	0	1	0	0	0	0	2	0	Librarian	12/3/2025	Wednesday
Day3_09-12 (Morning)	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	Researcher	13/3/2025	Thursday
Day3_12-15 (Midday)	1	0	1	1	0	0	0	0	1	3	4	3	0	0	1	2	0	1	1	0	0	Researcher	13/3/2025	Thursday
Day3_15-18 (Afternoon)	2	0	1	0	0	0	0	0	0	3	1	1	2	0	1	2	0	0	0	0	0	Researcher	13/3/2025	Thursday
Day4_09-12 (Morning)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	Researcher	14/3/2025	Friday
Day4_12-15 (Midday)	1	0	1	1	0	2	0	0	0	2	3	3	1	0	1	0	2	1	0	3	0	Researcher	14/3/2025	Friday
Day4_15-18 (Afternoon)	0	0	0	0	1	2	0	2	0	1	2	0	1	0	0	0	0	2	0	1	0	Researcher	14/3/2025	Friday
Day5_09-12 (Morning)	3	1	0	0	0	0	0	0	0	1	0	3	1	0	0	0	0	0	0	1	0	Researcher	17/3/2025	Monday
Day5_12-15 (Midday)	2	1	2	0	0	1	0	0	0	1	3	4	1	0	0	0	0	2	0	3	0	Researcher	17/3/2025	Monday
Day5_15-18 (Afternoon)	1	0	1	1	0	1	0	0	1	1	1	2	0	1	0	0	0	1	1	3	1	Researcher	17/3/2025	Monday
Day6_09-12 (Morning)	0	0	0	0	0	0	0	0	0	0	1	2	0	0	0	0	0	0	0	0	0	Researcher	18/3/2025	Tuesday
Day6_12-15 (Midday)	0	0	1	0	1	2	0	0	0	3	1	2	0	0	0	0	0	1	0	2	0	Researcher	18/3/2025	Tuesday
Day6_15-18 (Afternoon)	1	1	1	0	1	2	0	2	0	1	1	4	2	1	0	0	0	2	1	3	2	Researcher	18/3/2025	Tuesday
Day7_09-12 (Morning)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	Researcher	19/3/2025	Wednesday
Day7_12-15 (Midday)	2	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	2	0	0	1	0	Researcher	19/3/2025	Wednesday
Day7_15-18 (Afternoon)	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	3	0	Researcher	19/3/2025	Wednesday

Sum value Day1	0	0	2	2	0	1	1	2	0	3	1	4	0	0	0	0	0	0	0	2	2
Sum value Day2	4	0	0	0	4	3	0	5	1	2	2	6	0	0	1	0	0	0	2	2	2
Sum value Day3	5	0	2	1	0	0	0	0	1	6	5	4	2	0	2	4	0	1	1	0	0
Sum value Day4	1	0	1	1	1	4	0	2	0	3	5	3	2	0	1	0	2	3	0	4	0
Sum value Day5	6	2	3	1	0	2	0	0	1	3	4	9	2	1	0	0	0	3	1	7	1
Sum value Day6	1	1	2	0	2	4	0	2	0	4	3	8	2	1	0	0	0	3	1	5	2
Sum value Day7	2	0	0	0	0	0	0	2	0	2	0	0	0	0	0	0	2	0	0	4	0
Sum value all days	19	3	10	5	7	14	1	13	3	23	20	34	8	2	4	4	4	10	5	24	3
Average Occupancy Counts	5	1	3	1	2	4	0	3	1	6	5	9	2	1	1	1	1	3	1	6	1
Max average Occupancy Counts	9																				
Max count within time ranges	4																				

Sum value for mornings	5	1	1	1	0	0	0	0	0	1	1	5	1	0	0	0	0	0	0	2	0
sum value for middays	7	1	6	2	5	6	1	5	1	14	14	17	2	0	2	2	4	5	3	9	4
sum values for afternoons	7	1	3	2	2	8	0	8	2	8	5	12	5	2	2	2	0	5	2	13	3

Occupancy Time (Minutes)	Points																						
Days_Times	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	Observer	Date	Day
Day1_09-12 (Morning)	0	0	60	50	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	30	0	Librarian	11/3/2025	Tuesday
Day1_09-12 (Morning)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	Librarian	11/3/2025	Tuesday
Day1_09-12 (Morning)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	Librarian	11/3/2025	Tuesday
Day1_09-12 (Morning)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	Librarian	11/3/2025	Tuesday
Day1_12-15 (Midday)	0	0	60	0	0	15	10	45	0	15	120	10	0	0	0	0	0	0	0	0	90	Librarian	11/3/2025	Tuesday
Day1_12-15 (Midday)	0	0	0	0	0	0	0	45	0	0	120	0	0	0	0	0	0	0	0	0	90	Librarian	11/3/2025	Tuesday
Day1_12-15 (Midday)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	Librarian	11/3/2025	Tuesday
Day1_12-15 (Midday)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	Librarian	11/3/2025	Tuesday
Day1_15-18 (Afternoon)	0	0	0	120	0	0	0	0	0	30	0	90	0	0	0	0	0	0	0	60	0	Librarian	11/3/2025	Tuesday
Day1_15-18 (Afternoon)	0	0	0	0	0	0	0	0	0	30	0	90	0	0	0	0	0	0	0	0	0	Librarian	11/3/2025	Tuesday
Day1_15-18 (Afternoon)	0	0	0	0	0	0	0	0	0	0	0	90	0	0	0	0	0	0	0	0	0	Librarian	11/3/2025	Tuesday
Day1_15-18 (Afternoon)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	Librarian	11/3/2025	Tuesday
Day2_09-12 (Morning)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	Librarian	12/3/2025	Wednesday

Day2_09-12 (Morning)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	Librarian	12/3/2025 Wednesday
Day2_09-12 (Morning)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	Librarian	12/3/2025 Wednesday
Day2_09-12 (Morning)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	Librarian	12/3/2025 Wednesday
Day2_12-15 (Midday)	120	0	0	0	20	0	0	120	0	30	90	180	0	0	0	0	0	0	60	0	25	Librarian	12/3/2025 Wednesday
Day2_12-15 (Midday)	0	0	0	0	20	0	0	120	0	30	90	180	0	0	0	0	0	0	60	0	25	Librarian	12/3/2025 Wednesday
Day2_12-15 (Midday)	0	0	0	0	20	0	0	120	0	0	0	180	0	0	0	0	0	0	0	0	0	Librarian	12/3/2025 Wednesday
Day2_12-15 (Midday)	0	0	0	0	20	0	0	0	0	0	0	180	0	0	0	0	0	0	0	0	0	Librarian	12/3/2025 Wednesday
Day2_15-18 (Afternoon)	60	0	0	0	0	120	0	35	10	0	0	90	0	0	30	0	0	0	0	60	0	Librarian	12/3/2025 Wednesday
Day2_15-18 (Afternoon)	60	0	0	0	0	120	0	35	0	0	0	90	0	0	0	0	0	0	0	60	0	Librarian	12/3/2025 Wednesday
Day2_15-18 (Afternoon)	60	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	Librarian	12/3/2025 Wednesday
Day2_15-18 (Afternoon)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	Librarian	12/3/2025 Wednesday
Day3_09-12 (Morning)	15	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	Researcher	13/3/2025 Thursday
Day3_09-12 (Morning)	15	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	Researcher	13/3/2025 Thursday
Day3_09-12 (Morning)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	Researcher	13/3/2025 Thursday
Day3_09-12 (Morning)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	Researcher	13/3/2025 Thursday
Day3_12-15 (Midday)	5	0	120	60	0	0	0	0	0	30	60	10	0	0	30	60	0	60	30	0	0	Researcher	13/3/2025 Thursday
Day3_12-15 (Midday)	0	0	0	0	0	0	0	0	0	30	60	10	0	0	0	60	0	0	0	0	0	Researcher	13/3/2025 Thursday
Day3_12-15 (Midday)	0	0	0	0	0	0	0	0	0	30	10	60	0	0	0	0	0	0	0	0	0	Researcher	13/3/2025 Thursday
Day3_12-15 (Midday)	0	0	0	0	0	0	0	0	0	0	10	0	0	0	0	0	0	0	0	0	0	Researcher	13/3/2025 Thursday
Day3_15-18 (Afternoon)	10	0	120	0	0	0	0	0	0	10	15	15	60	0	60	30	0	0	0	0	0	Researcher	13/3/2025 Thursday
Day3_15-18 (Afternoon)	10	0	0	0	0	0	0	0	0	10	0	0	60	0	0	30	0	0	0	0	0	Researcher	13/3/2025 Thursday
Day3_15-18 (Afternoon)	0	0	0	0	0	0	0	0	0	10	0	0	0	0	0	0	0	0	0	0	0	Researcher	13/3/2025 Thursday
Day3_15-18 (Afternoon)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	Researcher	13/3/2025 Thursday
Day4_09-12 (Morning)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	Researcher	14/3/2025 Friday
Day4_09-12 (Morning)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	Researcher	14/3/2025 Friday
Day4_09-12 (Morning)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	Researcher	14/3/2025 Friday
Day4_09-12 (Morning)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	Researcher	14/3/2025 Friday
Day4_12-15 (Midday)	90	0	30	60	0	60	0	0	0	30	15	5	90	0	30	0	60	60	0	60	0	Researcher	14/3/2025 Friday
Day4_12-15 (Midday)	0	0	0	0	0	0	0	0	0	30	60	5	0	0	0	0	60	0	0	0	0	Researcher	14/3/2025 Friday
Day4_12-15 (Midday)	0	0	0	0	0	0	0	0	0	0	60	5	0	0	0	0	0	0	0	0	0	Researcher	14/3/2025 Friday
Day4_12-15 (Midday)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	Researcher	14/3/2025 Friday
Day4_15-18 (Afternoon)	0	0	0	0	30	30	0	30	0	5	10	0	15	0	0	0	0	30	0	40	0	Researcher	14/3/2025 Friday
Day4_15-18 (Afternoon)	0	0	0	0	0	30	0	30	0	0	10	0	0	0	0	0	0	30	0	40	0	Researcher	14/3/2025 Friday
Day4_15-18 (Afternoon)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	Researcher	14/3/2025 Friday
Day4_15-18 (Afternoon)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	Researcher	14/3/2025 Friday
Day5_09-12 (Morning)	10	20	0	0	0	0	0	0	0	5	0	90	60	0	0	0	0	0	0	30	0	Researcher	17/3/2025 Monday
Day5_09-12 (Morning)	10	0	0	0	0	0	0	0	0	0	0	90	0	0	0	0	0	0	0	0	0	Researcher	17/3/2025 Monday
Day5_09-12 (Morning)	10	0	0	0	0	0	0	0	0	0	0	90	0	0	0	0	0	0	0	0	0	Researcher	17/3/2025 Monday
Day5_09-12 (Morning)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	Researcher	17/3/2025 Monday
Day5_12-15 (Midday)	60	5	120	0	0	10	0	0	0	30	20	20	30	0	0	0	0	60	0	60	0	Researcher	17/3/2025 Monday
Day5_12-15 (Midday)	15	0	120	0	0	0	0	0	0	0	20	20	0	0	0	0	0	60	0	60	0	Researcher	17/3/2025 Monday
Day5_12-15 (Midday)	0	0	0	0	0	0	0	0	0	0	60	20	0	0	0	0	0	0	0	60	0	Researcher	17/3/2025 Monday
Day5_12-15 (Midday)	0	0	0	0	0	0	0	0	0	0	0	30	0	0	0	0	0	0	0	0	0	Researcher	17/3/2025 Monday
Day5_15-18 (Afternoon)	5	0	90	30	0	20	0	0	15	20	10	120	0	40	0	0	0	60	60	120	120	Researcher	17/3/2025 Monday
Day5_15-18 (Afternoon)	0	0	0	0	0	0	0	0	0	0	0	120	0	0	0	0	0	0	0	120	0	Researcher	17/3/2025 Monday
Day5_15-18 (Afternoon)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	120	0	Researcher	17/3/2025 Monday
Day5_15-18 (Afternoon)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	Researcher	17/3/2025 Monday
Day6_09-12 (Morning)	0	0	0	0	0	0	0	0	0	0	30	60	0	0	0	0	0	0	0	0	0	Researcher	18/3/2025 Tuesday
Day6_09-12 (Morning)	0	0	0	0	0	0	0	0	0	0	0	60	0	0	0	0	0	0	0	0	0	Researcher	18/3/2025 Tuesday
Day6_09-12 (Morning)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	Researcher	18/3/2025 Tuesday
Day6_09-12 (Morning)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	Researcher	18/3/2025 Tuesday
Day6_12-15 (Midday)	0	0	60	0	20	20	0	0	0	60	10	30	0	0	0	0	0	10	0	180	0	Researcher	18/3/2025 Tuesday
Day6_12-15 (Midday)	0	0	0	0	0	20	0	0	0	30	0	30	0	0	0	0	0	0	0	180	0	Researcher	18/3/2025 Tuesday
Day6_12-15 (Midday)	0	0	0	0	0	0	0	0	0	30	0	0	0	0	0	0	0	0	0	0	0	Researcher	18/3/2025 Tuesday
Day6_12-15 (Midday)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	Researcher	18/3/2025 Tuesday
Day6_15-18 (Afternoon)	10	60	30	0	15	15	0	60	0	30	60	60	10	20	0	0	0	40	60	120	120	Researcher	18/3/2025 Tuesday
Day6_15-18 (Afternoon)	0	0	0	0	0	15	0	60	0	0	0	60	30	0	0	0	0	40	0	120	120	Researcher	18/3/2025 Tuesday
Day6_15-18 (Afternoon)	0	0	0	0	0	0	0	0	0	0	0	20	0	0	0	0	0	0	0	120	0	Researcher	18/3/2025 Tuesday
Day6_15-18 (Afternoon)	0	0	0	0	0	0	0	0	0	0	0	20	0	0	0	0	0	0	0	0	0	Researcher	18/3/2025 Tuesday

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21			
Day7_09-12 (Morning)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	Researcher	19/3/2025	Wednesday
Day7_09-12 (Morning)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	Researcher	19/3/2025	Wednesday
Day7_09-12 (Morning)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	Researcher	19/3/2025	Wednesday
Day7_09-12 (Morning)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	Researcher	19/3/2025	Wednesday
Day7_12-15 (Midday)	5	0	0	0	0	0	0	0	0	60	0	0	0	0	0	0	30	0	0	60	0	Researcher	19/3/2025	Wednesday
Day7_12-15 (Midday)	20	0	0	0	0	0	0	0	0	15	0	0	0	0	0	0	0	0	0	0	0	Researcher	19/3/2025	Wednesday
Day7_12-15 (Midday)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	Researcher	19/3/2025	Wednesday
Day7_12-15 (Midday)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	Researcher	19/3/2025	Wednesday
Day7_15-18 (Afternoon)	0	0	0	0	0	0	0	30	0	0	0	0	0	0	0	0	0	0	0	60	0	Researcher	19/3/2025	Wednesday
Day7_15-18 (Afternoon)	0	0	0	0	0	0	0	30	0	0	0	0	0	0	0	0	0	0	0	60	0	Researcher	19/3/2025	Wednesday
Day7_15-18 (Afternoon)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	60	0	Researcher	19/3/2025	Wednesday
Day7_15-18 (Afternoon)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	Researcher	19/3/2025	Wednesday

Sum value Day1	0	0	120	170	0	15	10	90	0	75	240	280	0	0	0	0	0	0	0	90	180
Sum value Day2	300	0	0	0	80	240	0	430	10	60	180	900	0	0	30	0	0	0	120	120	50
Sum value Day3	55	0	240	60	0	0	0	0	0	120	155	95	120	0	90	180	0	60	30	0	0
Sum value Day4	90	0	30	60	30	120	0	60	0	65	155	15	105	0	30	0	120	120	0	140	0
Sum value Day5	110	25	330	30	0	30	0	0	15	55	110	600	90	40	0	0	0	180	60	570	120
Sum value Day6	10	60	90	0	35	70	0	120	0	150	100	340	40	20	0	0	0	90	60	720	240
Sum value Day7	25	0	0	0	0	0	0	60	0	75	0	0	0	0	0	0	30	0	0	240	0

Sum value for mornings	60	20	60	50	0	0	0	0	0	5	30	390	60	0	0	0	0	0	0	60	0
sum value for middays	315	5	510	120	100	125	10	450	0	450	805	975	120	0	60	120	150	250	150	660	230
sum values for afternoons	215	60	240	150	45	350	0	310	25	145	105	865	175	60	90	60	0	200	120	1160	360

Average time spent	7	1	10	4	2	6	0	9	0	7	11	27	4	1	2	2	2	5	3	22	7

Max time withing time ranges	180
Max average time spent	27
Max Average occupancy efficacy	226

	Points																				
occupancy data	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21
Utilization score	33	1	24	5	3	20	0	29	0	41	56	226	8	0	2	2	2	13	4	134	9
Normalized efficacy	0.1	0.0	0.1	0.0	0.0	0.1	0.0	0.1	0.0	0.2	0.2	1.0	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.6	0.0
Balanced efficacy	1.54	0.25	1.40	0.76	0.60	1.32	0.01	1.48	0.09	1.62	1.76	2.36	0.98	0.13	0.44	0.50	0.44	1.16	0.70	2.13	0.99
BE-Bemin	1.52	0.23	1.39	0.75	0.59	1.31	0.00	1.47	0.07	1.61	1.74	2.34	0.96	0.12	0.43	0.48	0.43	1.15	0.69	2.12	0.98
Balanced relative efficacy	0.6503	0.0993	0.5921	0.3192	0.2525	0.5571	0	0.6276	0.0319	0.6878	0.7439	1	0.411	0.0512	0.1845	0.2069	0.1845	0.4889	0.2936	0.9043	0.4173

BE max	2.36
BE min	0.01
BEmax-BEmin	2.34

Balanced Efficacy (Balanced Utilization score)=
BE = Log (1 + (Average Occupancy Counts × Average Time Spent))

$$\textbf{Balanced Relative Efficacy} = \frac{BE - BEmin}{BEmax - BEmin}$$

(time-specific)

APPENDIX 5.2 – Observation Sheet for Witomino in June

[illegible]	Points																							
Days_Times	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	Observer	Date	Day
Day1_09-12 (Morning)	0	2	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	Librarian	6/12/2025	Thursday
Day1_12-15 (Midday)	3	1	2	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	4	0	Librarian	6/12/2025	Thursday
Day1_15-18 (Afternoon)	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	6	1	Librarian	6/12/2025	Thursday
Day2_09-12 (Morning)	2	0	3	0	0	0	2	0	0	2	0	3	0	0	0	0	0	0	0	0	0	Librarian	6/13/2025	Friday
Day2_12-15 (Midday)	2	2	2	0	0	0	2	0	0	1	0	4	0	0	0	0	0	0	0	4	0	Librarian	6/13/2025	Friday
Day2_15-18 (Afternoon)	4	3	2	0	0	0	2	0	0	0	0	5	0	0	0	0	0	0	0	3	0	Librarian	6/13/2025	Friday
Day3_09-12 (Morning)	1	2	3	2	0	0	0	3	0	0	0	0	0	0	0	0	0	0	0	0	0	Librarian	6/14/2025	Saturday
Day3_12-15 (Midday)	2	1	1	0	0	0	0	4	0	0	0	0	0	0	0	0	0	0	0	0	0	Librarian	6/14/2025	Saturday
Day3_15-18 (Afternoon)	0	0	0	0	0	0	0	6	0	0	0	0	0	0	0	0	0	0	0	0	0	Librarian	6/14/2025	Saturday
Day4_09-12 (Morning)	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	Researcher	6/16/2025	Monday
Day4_12-15 (Midday)	1	2	1	0	0	0	0	0	0	0	0	2	0	1	0	0	0	2	2	2	1	Researcher	6/16/2025	Monday
Day4_15-18 (Afternoon)	1	1	2	0	0	1	2	3	1	2	5	0	1	2	0	2	2	2	3	3	2	Researcher	6/16/2025	Monday
Day5_09-12 (Morning)	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	Researcher	6/17/2025	Tuesday
Day5_12-15 (Midday)	1	0	0	1	0	0	0	0	0	0	1	1	0	0	1	0	0	0	0	0	1	Researcher	6/17/2025	Tuesday
Day5_15-18 (Afternoon)	0	1	0	0	1	4	4	3	1	2	2	2	2	2	0	0	0	2	0	0	1	Researcher	6/17/2025	Tuesday
Day6_09-12 (Morning)	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	Researcher	6/18/2025	Wednesday
Day6_12-15 (Midday)	0	0	1	0	1	0	1	0	0	1	0	0	0	0	0	0	0	0	0	0	0	Researcher	6/18/2025	Wednesday
Day6_15-18 (Afternoon)	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	Researcher	6/18/2025	Wednesday
Day7_09-12 (Morning)	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	Researcher	6/20/2025	Friday
Day7_12-15 (Midday)	1	0	0	0	2	0	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0	Researcher	6/20/2025	Friday
Day7_15-18 (Afternoon)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	Researcher	6/20/2025	Friday

Sum value Day1	5	6	7	1	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	12	1
Sum value Day2	8	3	7	0	0	0	6	0	0	3	0	12	0	0	0	0	0	0	0	9	0
Sum value Day3	3	5	8	2	0	0	0	13	0	0	0	0	0	0	0	0	0	0	0	0	0
Sum value Day4	2	3	4	0	0	1	2	3	1	2	5	2	1	3	0	2	2	4	4	5	3
Sum value Day5	2	1	0	1	1	4	4	3	1	2	3	3	2	2	1	0	0	2	0	0	2
Sum value Day6	2	0	2	0	1	0	1	0	0	1	0	0	0	0	0	0	0	0	0	0	0
Sum value Day7	1	0	1	0	2	0	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0
Sum value all days	23	20	27	4	8	5	13	19	2	8	8	12	3	5	1	3	2	9	4	20	20
Average Occupancy Counts	6	5	7	1	2	1	3	3	1	2	2	4	1	1	0	1	1	2	1	7	3
Max average Occupancy Counts	7																				
Max count within time ranges	6																				

Sum value for mornings	5	4	10	2	0	0	2	3	0	2	0	3	0	0	0	0	0	0	0	2	0
sum value for middays	9	8	9	2	3	0	3	4	0	3	2	7	0	1	1	0	0	2	2	10	2
sum values for afternoons	9	8	8	0	3	5	8	12	2	4	7	7	3	4	0	3	2	7	2	14	4

[illegible]	Points																							
Days_Times	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	Observer	Date	Day
Day1_09-12 (Morning)	0	30	120	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	120	0	Librarian	6/12/2025	Thursday
Day1_09-12 (Morning)	0	30	120	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	120	0	Librarian	6/12/2025	Thursday
Day1_09-12 (Morning)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	Librarian	6/12/2025	Thursday
Day1_09-12 (Morning)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	Librarian	6/12/2025	Thursday
Day1_09-12 (Morning)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	Librarian	6/12/2025	Thursday
Day1_09-12 (Morning)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	Librarian	6/12/2025	Thursday
Day1_12-15 (Midday)	60	60	60	120	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	120	0	Librarian	6/12/2025	Thursday
Day1_12-15 (Midday)	60	0	60	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	120	0	Librarian	6/12/2025	Thursday
Day1_12-15 (Midday)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	120	0	Librarian	6/12/2025	Thursday
Day1_12-15 (Midday)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	120	0	Librarian	6/12/2025	Thursday
Day1_12-15 (Midday)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	Librarian	6/12/2025	Thursday
Day1_12-15 (Midday)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	Librarian	6/12/2025	Thursday
Day1_15-18 (Afternoon)	60	60	60	0	0	0	0	0	0	0	0	0	0	0	0	0	0	180	0	180	180	Librarian	6/12/2025	Thursday
Day1_15-18 (Afternoon)	60	60	60	0	0	0	0	0	0	0	0	0	0	0	0	0	0	180	0	180	0	Librarian	6/12/2025	Thursday
Day1_15-18 (Afternoon)	60	60	60	0	0	0	0	0	0	0	0	0	0	0	0	0	0	180	0	180	0	Librarian	6/12/2025	Thursday
Day1_15-18 (Afternoon)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	180	0	Librarian	6/12/2025	Thursday
Day1_15-18 (Afternoon)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	180	0	Librarian	6/12/2025	Thursday
Day1_15-18 (Afternoon)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	180	0	Librarian	6/12/2025	Thursday
Day2_09-12 (Morning)	60	0	60	0	0	0	45	0	0	60	0	60	0	0	0	0	0	0	0	0	0	Librarian	6/13/2025	Friday
Day2_09-12 (Morning)	60	0	60	0	0	0	45	0	0	60	0	60	0	0	0	0	0	0	0	0	0	Librarian	6/13/2025	Friday
Day2_09-12 (Morning)	0	0	60	0	0	0	0	0	0	0	0	60	0	0	0	0	0	0	0	0	0	Librarian	6/13/2025	Friday
Day2_09-12 (Morning)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	Librarian	6/13/2025	Friday
Day2_09-12 (Morning)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	Librarian	6/13/2025	Friday
Day2_09-12 (Morning)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	Librarian	6/13/2025	Friday
Day2_12-15 (Midday)	60	60	60	0	0	0	45	0	0	60	0	120	0	0	0	0	0	0	0	60	0	Librarian	6/13/2025	Friday

Day2_12-15 (Midday)	60	60	60	0	0	0	45	0	0	0	0	120	0	0	0	0	0	0	0	60	0	Librarian	6/13/2025	Friday
Day2_12-15 (Midday)	0	0	0	0	0	0	0	0	0	0	0	120	0	0	0	0	0	0	0	60	0	Librarian	6/13/2025	Friday
Day2_12-15 (Midday)	0	0	0	0	0	0	0	0	0	0	0	120	0	0	0	0	0	0	0	60	0	Librarian	6/13/2025	Friday
Day2_12-15 (Midday)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	Librarian	6/13/2025	Friday
Day2_12-15 (Midday)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	Librarian	6/13/2025	Friday
Day2_15-18 (Afternoon)	60	60	60	0	0	0	45	0	0	0	0	120	0	0	0	0	0	0	0	60	0	Librarian	6/13/2025	Friday
Day2_15-18 (Afternoon)	60	60	60	0	0	0	45	0	0	0	0	120	0	0	0	0	0	0	0	60	0	Librarian	6/13/2025	Friday
Day2_15-18 (Afternoon)	60	60	0	0	0	0	0	0	0	0	0	120	0	0	0	0	0	0	0	60	0	Librarian	6/13/2025	Friday
Day2_15-18 (Afternoon)	60	0	0	0	0	0	0	0	0	0	0	120	0	0	0	0	0	0	0	60	0	Librarian	6/13/2025	Friday
Day2_15-18 (Afternoon)	0	0	0	0	0	0	0	0	0	0	0	120	0	0	0	0	0	0	0	60	0	Librarian	6/13/2025	Friday
Day2_15-18 (Afternoon)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	Librarian	6/13/2025	Friday
Day3_09-12 (Morning)	30	60	60	60	0	0	0	60	0	0	0	0	0	0	0	0	0	0	0	0	0	Librarian	6/14/2025	Saturday
Day3_09-12 (Morning)	0	60	60	60	0	0	0	60	0	0	0	0	0	0	0	0	0	0	0	0	0	Librarian	6/14/2025	Saturday
Day3_09-12 (Morning)	0	0	60	0	0	0	0	60	0	0	0	0	0	0	0	0	0	0	0	0	0	Librarian	6/14/2025	Saturday
Day3_09-12 (Morning)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	Librarian	6/14/2025	Saturday
Day3_09-12 (Morning)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	Librarian	6/14/2025	Saturday
Day3_09-12 (Morning)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	Librarian	6/14/2025	Saturday
Day3_12-15 (Midday)	60	60	60	0	0	0	0	60	0	0	0	0	0	0	0	0	0	0	0	0	0	Librarian	6/14/2025	Saturday
Day3_12-15 (Midday)	60	60	60	0	0	0	0	60	0	0	0	0	0	0	0	0	0	0	0	0	0	Librarian	6/14/2025	Saturday
Day3_12-15 (Midday)	0	60	60	0	0	0	0	60	0	0	0	0	0	0	0	0	0	0	0	0	0	Librarian	6/14/2025	Saturday
Day3_12-15 (Midday)	0	0	0	0	0	0	0	60	0	0	0	0	0	0	0	0	0	0	0	0	0	Librarian	6/14/2025	Saturday
Day3_12-15 (Midday)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	Librarian	6/14/2025	Saturday
Day3_12-15 (Midday)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	Librarian	6/14/2025	Saturday
Day3_15-18 (Afternoon)	0	0	0	0	0	0	0	45	0	0	0	0	0	0	0	0	0	0	0	0	0	Librarian	6/14/2025	Saturday
Day3_15-18 (Afternoon)	0	0	0	0	0	0	0	45	0	0	0	0	0	0	0	0	0	0	0	0	0	Librarian	6/14/2025	Saturday
Day3_15-18 (Afternoon)	0	0	0	0	0	0	0	45	0	0	0	0	0	0	0	0	0	0	0	0	0	Librarian	6/14/2025	Saturday
Day3_15-18 (Afternoon)	0	0	0	0	0	0	0	45	0	0	0	0	0	0	0	0	0	0	0	0	0	Librarian	6/14/2025	Saturday
Day3_15-18 (Afternoon)	0	0	0	0	0	0	0	45	0	0	0	0	0	0	0	0	0	0	0	0	0	Librarian	6/14/2025	Saturday
Day3_15-18 (Afternoon)	0	0	0	0	0	0	0	45	0	0	0	0	0	0	0	0	0	0	0	0	0	Librarian	6/14/2025	Saturday
Day4_09-12 (Morning)	0	0	15	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	Researcher	6/16/2025	Monday
Day4_09-12 (Morning)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	Researcher	6/16/2025	Monday
Day4_09-12 (Morning)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	Researcher	6/16/2025	Monday
Day4_09-12 (Morning)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	Researcher	6/16/2025	Monday
Day4_09-12 (Morning)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	Researcher	6/16/2025	Monday
Day4_09-12 (Morning)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	Researcher	6/16/2025	Monday
Day4_12-15 (Midday)	10	5	180	0	0	0	0	0	0	0	0	10	0	10	0	0	0	60	60	60	90	Researcher	6/16/2025	Monday
Day4_12-15 (Midday)	0	60	0	0	0	0	0	0	0	0	0	10	0	0	0	0	0	60	90	120	0	Researcher	6/16/2025	Monday
Day4_12-15 (Midday)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	Researcher	6/16/2025	Monday
Day4_12-15 (Midday)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	Researcher	6/16/2025	Monday
Day4_12-15 (Midday)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	Researcher	6/16/2025	Monday
Day4_12-15 (Midday)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	Researcher	6/16/2025	Monday
Day4_15-18 (Afternoon)	10	0	30	0	0	30	30	30	20	5	40	0	30	20	0	20	20	30	30	15	10	Researcher	6/16/2025	Monday
Day4_15-18 (Afternoon)	0	0	30	0	0	0	30	30	0	5	40	0	0	30	0	20	20	30	30	15	10	Researcher	6/16/2025	Monday
Day4_15-18 (Afternoon)	0	0	0	0	0	0	0	30	0	0	40	0	0	0	0	0	0	0	0	60	0	Researcher	6/16/2025	Monday
Day4_15-18 (Afternoon)	0	0	0	0	0	0	0	0	0	0	40	0	0	0	0	0	0	0	0	0	0	Researcher	6/16/2025	Monday
Day4_15-18 (Afternoon)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	Researcher	6/16/2025	Monday
Day4_15-18 (Afternoon)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	Researcher	6/16/2025	Monday
Day5_09-12 (Morning)	10	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	Researcher	6/17/2025	Tuesday
Day5_09-12 (Morning)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	Researcher	6/17/2025	Tuesday
Day5_09-12 (Morning)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	Researcher	6/17/2025	Tuesday
Day5_09-12 (Morning)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	Researcher	6/17/2025	Tuesday
Day5_09-12 (Morning)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	Researcher	6/17/2025	Tuesday
Day5_09-12 (Morning)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	Researcher	6/17/2025	Tuesday
Day5_12-15 (Midday)	15	0	0	90	0	0	0	0	0	0	40	120	0	0	10	0	0	0	0	0	30	Researcher	6/17/2025	Tuesday
Day5_12-15 (Midday)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	Researcher	6/17/2025	Tuesday
Day5_12-15 (Midday)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	Researcher	6/17/2025	Tuesday
Day5_12-15 (Midday)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	Researcher	6/17/2025	Tuesday
Day5_12-15 (Midday)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	Researcher	6/17/2025	Tuesday
Day5_12-15 (Midday)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	Researcher	6/17/2025	Tuesday
Day5_15-18 (Afternoon)	0	10	0	0	60	15	15	30	30	5	40	30	10	30	0	0	0	10	0	0	60	Researcher	6/17/2025	Tuesday
Day5_15-18 (Afternoon)	0	0	0	0	60	30	15	30	0	5	40	10	120	30	0	0	0	10	0	0	0	Researcher	6/17/2025	Tuesday
Day5_15-18 (Afternoon)	0	0	0	0	60	60	60	30	0	0	0	0	0	0	0	0	0	0	0	0	0	Researcher	6/17/2025	Tuesday
Day5_15-18 (Afternoon)	0	0	0	0	0	60	60	0	0	0	0	0	0	0	0	0	0	0	0	0	0	Researcher	6/17/2025	Tuesday
Day5_15-18 (Afternoon)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	Researcher	6/17/2025	Tuesday
Day5_15-18 (Afternoon)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	Researcher	6/17/2025	Tuesday
Day6_09-12 (Morning)	10	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	Researcher	6/18/2025	Wednesday
Day6_09-12 (Morning)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	Researcher	6/18/2025	Wednesday
Day6_09-12 (Morning)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	Researcher	6/18/2025	Wednesday
Day6_09-12 (Morning)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	Researcher	6/18/2025	Wednesday
Day6_09-12 (Morning)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	Researcher	6/18/2025	Wednesday
Day6_09-12 (Morning)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	Researcher	6/18/2025	Wednesday
Day6_12-15 (Midday)	0	0	120	0	10	0	20	0	0	10	0	0	0	0	0	0	0	0	0	0	0	Researcher	6/18/2025	Wednesday

Day6_12-15 (Midday)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	Researcher	6/18/2025	Wednesday
Day6_12-15 (Midday)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	Researcher	6/18/2025	Wednesday
Day6_12-15 (Midday)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	Researcher	6/18/2025	Wednesday
Day6_12-15 (Midday)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	Researcher	6/18/2025	Wednesday
Day6_12-15 (Midday)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	Researcher	6/18/2025	Wednesday
Day6_15-18 (Afternoon)	60	0	180	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	Researcher	6/18/2025	Wednesday
Day6_15-18 (Afternoon)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	Researcher	6/18/2025	Wednesday
Day6_15-18 (Afternoon)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	Researcher	6/18/2025	Wednesday
Day6_15-18 (Afternoon)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	Researcher	6/18/2025	Wednesday
Day6_15-18 (Afternoon)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	Researcher	6/18/2025	Wednesday
Day6_15-18 (Afternoon)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	Researcher	6/18/2025	Wednesday
Day7_09-12 (Morning)	0	0	60	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	Researcher	6/20/2025	Friday
Day7_09-12 (Morning)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	Researcher	6/20/2025	Friday
Day7_09-12 (Morning)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	Researcher	6/20/2025	Friday
Day7_09-12 (Morning)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	Researcher	6/20/2025	Friday
Day7_09-12 (Morning)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	Researcher	6/20/2025	Friday
Day7_09-12 (Morning)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	Researcher	6/20/2025	Friday
Day7_12-15 (Midday)	10	0	0	0	60	0	0	0	0	20	20	0	0	0	0	0	0	0	0	0	0	Researcher	6/20/2025	Friday
Day7_12-15 (Midday)	0	0	0	0	60	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	Researcher	6/20/2025	Friday
Day7_12-15 (Midday)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	Researcher	6/20/2025	Friday
Day7_12-15 (Midday)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	Researcher	6/20/2025	Friday
Day7_12-15 (Midday)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	Researcher	6/20/2025	Friday
Day7_12-15 (Midday)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	Researcher	6/20/2025	Friday
Day7_15-18 (Afternoon)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	Researcher	6/20/2025	Friday
Day7_15-18 (Afternoon)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	Researcher	6/20/2025	Friday
Day7_15-18 (Afternoon)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	Researcher	6/20/2025	Friday
Day7_15-18 (Afternoon)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	Researcher	6/20/2025	Friday
Day7_15-18 (Afternoon)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	Researcher	6/20/2025	Friday
Day7_15-18 (Afternoon)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	Researcher	6/20/2025	Friday

Sum value Day1	300	300	540	120	0	0	0	0	0	0	0	0	0	0	0	0	0	540	0	1800	180
Sum value Day2	480	300	420	0	0	0	270	0	0	180	0	1260	0	0	0	0	0	0	0	540	0
Sum value Day3	150	300	380	120	0	0	0	690	0	0	0	0	0	0	0	0	0	0	0	0	0
Sum value Day4	20	65	255	0	0	30	60	90	20	10	160	20	20	50	0	40	40	180	180	270	80
Sum value Day5	25	10	0	90	180	165	150	90	30	10	120	160	130	60	10	0	0	20	0	0	90
Sum value Day6	70	0	300	0	10	0	20	0	0	10	0	0	0	0	0	0	0	0	0	0	0
Sum value Day7	10	0	60	0	120	0	0	0	0	20	20	0	0	0	0	0	0	0	0	0	0
Sum value for mornings	170	180	675	120	0	0	90	180	0	120	0	180	0	0	0	0	0	0	0	240	0
sum value for middays	395	425	720	210	130	0	110	240	0	90	60	620	0	10	10	0	0	120	120	900	90
sum values for afternoons	490	370	540	0	180	195	300	450	50	20	240	640	150	100	0	40	40	620	60	1470	200
Average time spent	8	8	15	3	2	2	4	7	0	2	2	11	1	1	0	0	0	6	1	21	3

Max time withing time ranges	180
Max average time spent	21
Max Average occupancy efficacy	140

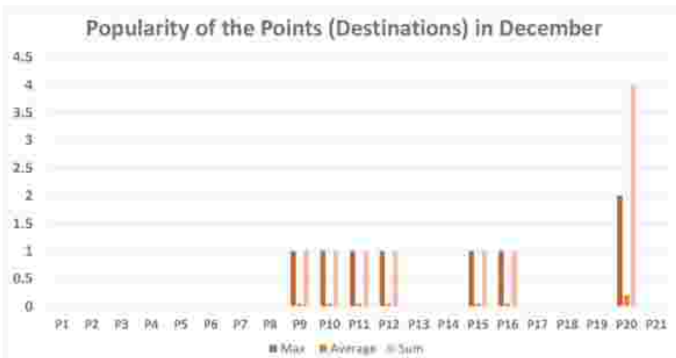
	Points																				
occupancy data	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21
Utilization score	48	39	104	3	4	2	13	33	0	4	5	49	1	1	0	0	0	13	1	135	9
Normalized efficacy	0.3	0.3	0.7	0.0	0.0	0.0	0.1	0.2	0.0	0.0	0.0	0.3	0.0	0.0	0.0	0.0	0.0	0.1	0.0	1.0	0.1
Balanced efficacy	1.69	1.60	2.02	0.56	0.67	0.47	1.14	1.53	0.08	0.71	0.80	1.70	0.28	0.32	0.01	0.06	0.06	1.15	0.39	2.13	1.00
BE-Bemin	1.68	1.59	2.01	0.55	0.66	0.46	1.13	1.52	0.07	0.70	0.79	1.69	0.27	0.31	0.00	0.06	0.06	1.14	0.38	2.12	0.99
Balanced relative efficacy	0.792398	0.748708	0.946977	0.258991	0.312018	0.216118	0.534113	0.715843	0.032994	0.32942	0.37419	0.794165	0.126461	0.146844	0	0.026108	0.026108	0.538731	0.177421	1	0.46739

BE max	2.13
BE min	0.01
BEmax-BEmin	2.12

Balanced Efficacy (Balanced Utilization score)=
BE = Log (1 + (Average Occupancy Counts × Average Time Spent))

Balanced Relative Efficacy (time-specific) $= \dfrac{\textbf{BE - BEmin}}{\textbf{BEmax - BEmin}}$

APPENDIX 5.1 – Observation Sheet of Movement Intensity for Witomino in December

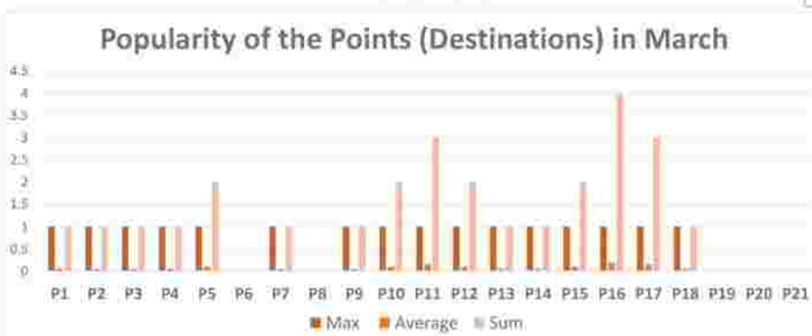


Origin-Destination Matrix

Points	P1	P2	P3	P4	P5	P6	P7	P8	P9	P10	P11	P12	P13	P14	P15	P16	P17	P18	P19	P20	P21
P1	N/A	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
P2	0	N/A	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
P3	0	0	N/A	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
P4	0	0	0	N/A	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
P5	0	0	0	0	N/A	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0
P6	0	0	0	0	0	N/A	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
P7	0	0	0	0	0	0	N/A	0	0	0	0	1	0	0	0	0	0	0	0	0	0
P8	0	0	0	0	0	0	0	N/A	0	1	0	0	0	0	0	0	0	0	0	0	0
P9	0	0	0	0	0	0	0	0	N/A	0	0	0	0	0	0	1	0	0	0	0	0
P10	0	0	0	0	0	0	0	0	0	N/A	0	0	0	0	0	0	0	0	0	0	0
P11	0	0	0	0	0	0	0	0	0	0	N/A	0	0	0	0	0	0	0	0	2	0
P12	0	0	0	0	0	0	0	0	0	0	0	N/A	0	0	0	0	0	0	0	2	0
P13	0	0	0	0	0	0	0	0	0	0	0	0	N/A	0	1	0	0	0	0	0	0
P14	0	0	0	0	0	0	0	0	0	0	0	0	0	N/A	0	0	0	0	0	0	0
P15	0	0	0	0	0	0	0	0	0	0	0	0	0	0	N/A	0	0	0	0	0	0
P16	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	N/A	0	0	0	0	0
P17	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	N/A	0	0	0	0
P18	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	N/A	0	0	0
P19	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	N/A	0	0
P20	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	N/A	0
P21	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	N/A

Points	P1	P2	P3	P4	P5	P6	P7	P8	P9	P10	P11	P12	P13	P14	P15	P16	P17	P18	P19	P20	P21
Max	0	0	0	0	0	0	0	0	1	1	1	1	0	0	1	1	0	0	0	2	0
Average	0	0	0	0	0	0	0	0	0.05	0.05	0.05	0.05	0	0	0.05	0.05	0	0	0	0.2	0
Sum	0	0	0	0	0	0	0	0	1	1	1	1	0	0	1	1	0	0	0	4	0

APPENDIX 5.1 – Observation Sheet of Movement Intensity for Witomino in March

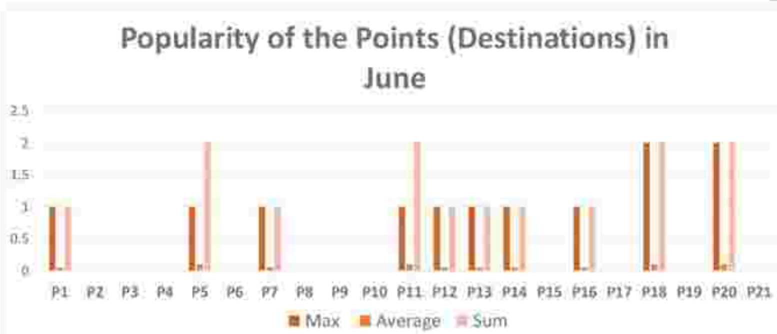


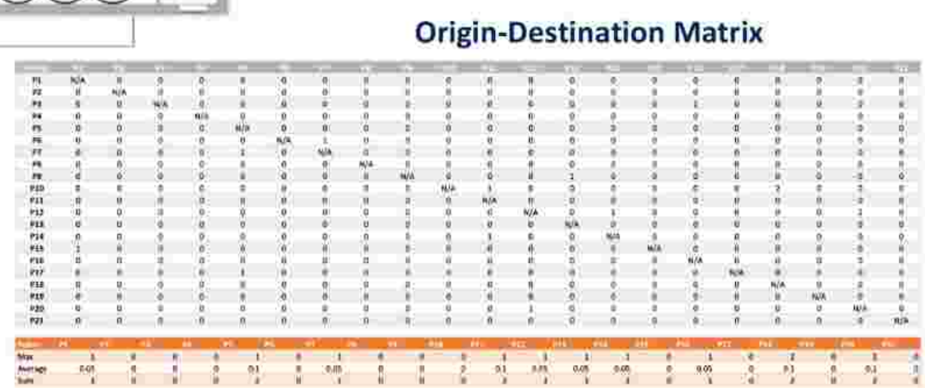
Origin-Destination Matrix

	P1	P2	P3	P4	P5	P6	P7	P8	P9	P10	P11	P12	P13	P14	P15	P16	P17	P18	P19	P20	P21
P1	N/A	0	0	1	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0
P2	[illegible]	N/A	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
P3	0	0	N/A	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
P4	0	0	0	N/A	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0
P5	0	0	0	0	N/A	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
P6	0	0	0	0	0	N/A	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
P7	0	0	0	0	0	0	N/A	0	0	0	0	0	0	0	0	0	0	0	0	0	0
P8	0	0	0	0	0	0	0	N/A	0	0	0	0	0	0	0	0	0	0	0	0	0
P9	0	0	0	0	0	0	0	0	N/A	0	0	0	0	0	0	0	0	0	0	0	0
P10	1	0	0	0	1	0	0	0	0	N/A	0	0	0	0	0	1	1	0	0	0	0
P11	0	0	0	0	1	0	0	0	0	0	N/A	0	0	0	0	0	1	0	0	0	0
P12	0	0	0	0	0	0	0	0	0	0	0	N/A	0	1	0	1	1	0	0	0	0
P13	0	0	0	0	0	0	0	0	0	0	0	0	N/A	0	0	0	0	0	0	0	0
P14	0	0	0	0	0	0	0	0	0	0	0	1	0	N/A	0	0	0	1	0	0	0
P15	0	0	0	0	0	0	0	0	0	0	0	0	0	0	N/A	0	0	0	0	0	0
P16	0	0	1	0	0	0	0	0	0	1	0	0	1	0	1	N/A	0	0	0	0	0
P17	0	0	0	0	0	0	0	0	0	1	0	1	0	0	0	0	N/A	0	0	0	0
P18	0	1	0	0	0	0	0	0	0	0	1	0	0	0	1	0	0	N/A	0	0	0
P19	0	0	0	0	0	0	0	0	1	0	1	0	0	0	0	0	0	0	N/A	0	0
P20	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	N/A	0
P21	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	N/A

	P1	P2	P3	P4	P5	P6	P7	P8	P9	P10	P11	P12	P13	P14	P15	P16	P17	P18	P19	P20	P21
Max	1	1	1	1	1	0	1	0	1	1	1	1	1	1	1	1	1	1	0	0	0
Average	0.05	0.05	0.05	0.05	0.1	0	0.05	0	0.05	0.1	0.15	0.1	0.05	0.05	0.1	0.2	0.15	0.05	0	0	0
Sum	1	1	1	1	2	0	1	0	1	2	3	2	1	1	2	4	3	1	0	0	0

APPENDIX 5.1 – Observation Sheet of Movement Intensity for Witomino in June





APPENDIX 6.1 – Movement Scores for Maly Kack

	December Week Efficacy		December Week Movement Intensity		March Week Efficacy	
Point Number	Balanced Relative Efficacy in December	Balanced Relative Efficacy Score in December	Movement Intensity for One Week in December (Max)	Movement Intensity for One Week in December (Sum)	Balanced Relative Efficacy in March	Balanced Relative Efficacy Score in March
Point 1	1.00	4	9	12	1.00	4
Point 2	0.74	3	1	1	0.65	3
Point 3	0.89	4	9	10	0.99	4
Point 4	0.60	3	3	6	0.93	4
Point 5	0.54	3	1	3	0.83	4
Point 6	0.49	2	0	0	0.20	1
Point 7	0.56	3	1	1	0.51	3
Point 8	0.60	3	1	1	0.32	2
Point 9	0.51	3	2	3	0.64	3
Point 10	0.19	1	2	4	0.00	1
Point 11	0.52	3	1	2	0.79	4
Point 12	0.35	2	1	1	0.10	1
Point 13	0.00	1	0	0	0.04	1
Point 14	0.23	1	1	1	0.58	3
Point 15	0.35	2	0	0	0.40	2
Point 16	0.59	3	0	0	0.20	1
Point 17	0.33	2	2	2	0.47	2

	March Week Movement Intensity		June Week Efficacy		December Week Movement Intensity	
Point Number	Movement Intensity for One Week in March (Max)	Movement Intensity for One Week in March (Sum)	Balanced Relative Efficacy in June	Balanced Relative Efficacy Score in June	Movement Intensity for One Week in June (Max)	Movement Intensity for One Week in June (Sum)
Point 1	2	3	0.98	4	5	6
Point 2	1	4	0.74	3	3	6
Point 3	10	12	1.00	4	8	12
Point 4	1	3	0.85	4	3	8
Point 5	2	5	0.50	3	1	1
Point 6	2	2	0.79	4	1	3
Point 7	2	2	0.46	2	1	2
Point 8	1	1	0.68	3	1	2
Point 9	1	2	0.67	3	1	2
Point 10	0	0	0.04	1	1	1
Point 11	3	8	0.82	4	2	4
Point 12	1	3	0.28	2	1	2
Point 13	1	1	0.00	1	1	1
Point 14	1	1	0.58	3	1	2
Point 15	1	1	0.01	1	0	0
Point 16	0	0	0.25	2	1	2
Point 17	0	0	0.06	1	0	0

APPENDIX 6.2 – Movement Scores for Witomino

	December Week Efficacy		December Week Movement Intensity		March Week Efficacy	
Point Number	Balanced Relative Efficacy in December	Balanced Relative Efficacy Score in December	Movement Intensity for One Week in December (Max)	Movement Intensity for One Week in December (Sum)	Balanced Relative Efficacy in March	Balanced Relative Efficacy Score in March
Point 1	0.33	2	0	0	0.65	3
Point 2	0.00	1	0	0	0.10	1
Point 3	0.26	2	0	0	0.59	3
Point 4	0.00	1	0	0	0.32	2
Point 5	0.00	1	0	0	0.25	2
Point 6	0.37	2	0	0	0.56	3
Point 7	0.15	1	0	0	0.00	1
Point 8	0.77	4	0	0	0.63	3
Point 9	0.03	1	1	1	0.03	1
Point 10	0.47	2	1	1	0.69	3
Point 11	0.81	4	1	1	0.74	3
Point 12	1.00	4	1	1	1.00	4
Point 13	0.64	3	0	0	0.41	2
Point 14	0.01	1	0	0	0.05	1
Point 15	0.00	1	1	1	0.18	1
Point 16	0.20	1	1	1	0.21	1
Point 17	0.20	1	0	0	0.18	1
Point 18	0.29	2	0	0	0.49	2
Point 19	0.38	2	0	0	0.29	2
Point 20	0.86	4	2	4	0.90	4
Point 21	0.47	2	0	0	0.42	2

	March Week		June Week Efficacy		December Week	
Point Number	Movement Intensity for One Week in March (Max)	Movement Intensity for One Week in March (Sum)	Balanced Relative Efficacy in June	Balanced Relative Efficacy Score in June	Movement Intensity for One Week in June (Max)	Movement Intensity for One Week in June (Sum)
Point 1	1	1	0.79	4	1	1
Point 2	1	1	0.75	3	0	0
Point 3	1	1	0.95	4	0	0
Point 4	1	1	0.26	2	0	0
Point 5	1	2	0.31	2	1	2
Point 6	0	0	0.22	1	0	0
Point 7	1	1	0.53	3	1	1
Point 8	0	0	0.72	3	0	0
Point 9	1	1	0.03	1	0	0
Point 10	1	2	0.33	2	0	0
Point 11	1	3	0.37	2	1	2
Point 12	1	2	0.79	4	1	1
Point 13	1	1	0.13	1	1	1
Point 14	1	1	0.15	1	1	1
Point 15	1	2	0.00	1	0	0
Point 16	1	4	0.03	1	1	1
Point 17	1	3	0.03	1	0	0
Point 18	1.00	1	0.54	3	2.00	2
Point 19	0.00	0	0.18	1	0.00	0
Point 20	0.00	0	1.00	4	2.00	2
Point 21	0.00	0	0.47	2	0.00	0

APPENDIX 7.1 – Daylighting Scores for Maly Kack

Note:

In this study, glare discomfort at each measurement point was quantified using a scale of 1 to 4 from four cardinal directions according to the OVNI. To incorporate both overall visual comfort and sensitivity to extreme glare conditions, the researcher computed the average glare score per point and applied a penalty of one point if any directional glare score indicated severe discomfort (score = 1). This approach balances sensitivity to localized intense glare with a robust aggregate measure of typical glare exposure. Applying the penalty once per point prevents over-penalization due to multiple glare incidences that may occur at different times or directions, thus reflecting realistic occupant experience without excessive bias.

	Daylight Provision (OVNI)				UDI			
Point No	DP annual	Dec DP	March DP	June DP	UDI Annual Score (OWL grid)	UDI Dec Score (OWL grid)	UDI March Score (OWL grid)	UDI June Score (OWL grid)
1	1	1	1	1	3	1	4	4
2	3	1	3	3	4	3	4	4
3	4	3	4	4	2	4	2	1
4	4	3	4	4	2	4	2	1
5	4	1	4	4	3	4	3	2
6	4	1	4	4	3	4	3	2
7	4	1	4	4	3	4	2	1
8	4	3	4	4	2	4	1	1
9	4	3	4	4	1	4	1	1
10	4	1	4	4	4	4	4	3
11	1	1	1	1	4	3	4	4
12	4	1	4	4	2	4	2	1
13	1	1	1	1	1	1	1	1
14	4	1	4	4	2	4	3	2
15	4	4	4	4	1	4	1	1
16	4	1	4	4	4	2	4	3
17	4	1	4	4	3	4	4	1

	Annual Glare Control					
Point No	North Glare Annual Score (OVNI)	East Glare Annual Score (OVNI)	West Glare Annual Score (OVNI)	South Glare Annual Score (OVNI)	Glare Annual Score (OVNI)	Annual Glare Sensitivity-Adjusted Score
1	4	4	4	4	4	4
2	4	4	4	4	4	4
3	1	2	1	1	1	1
4	2	3	1	3	2	1
5	2	4	1	3	3	2
6	2	4	1	2	2	1
7	1	4	1	3	2	1
8	1	4	1	3	2	1
9	1	1	2	4	2	1
10	2	4	1	4	3	2
11	4	4	4	4	4	4
12	4	3	3	1	3	2
13	1	3	1	1	2	1
14	4	2	4	4	4	4
15	1	1	2	4	2	1
16	4	4	4	4	4	4
17	2	4	3	4	3	3

Glare Control in December

Point No	North Glare Dec Score (OVNI)	East Glare Dec Score (OVNI)	West Glare Dec Score (OVNI)	South Glare Dec Score (OVNI)	Glare Dec Score (OVNI)	December Glare Sensitivity-Adjusted Score
1	4	4	4	4	4	4
2	4	4	4	4	4	4
3	4	4	4	4	4	4
4	4	4	4	4	4	4
5	4	4	4	4	4	4
6	4	4	4	4	4	4
7	4	4	4	4	4	4
8	4	4	4	4	4	4
9	4	4	4	4	4	4
10	4	4	4	4	4	4
11	4	4	4	4	4	4
12	4	4	4	3	4	4
13	4	4	4	4	4	4
14	4	4	4	4	4	4
15	4	4	4	4	4	4
16	4	4	4	4	4	4
17	4	4	4	4	4	4

Glare Control in March

Point No	North Glare March Score (OVNI)	East Glare March Score (OVNI)	West Glare March Score (OVNI)	South Glare March Score (OVNI)	Glare March Score (OVNI)	March Glare Sensitivity-Adjusted Score
1	4	4	4	4	4	4
2	4	4	4	4	4	4
3	3	4	4	4	4	4
4	4	4	3	4	4	4
5	3	4	1	1	2	1
6	3	4	1	1	2	1
7	2	4	1	1	2	1
8	1	4	1	1	2	1
9	1	1	1	4	2	1
10	3	4	1	4	3	2
11	4	4	4	4	4	4
12	4	1	1	1	2	1
13	1	4	1	1	2	1
14	4	2	4	4	4	4
15	1	1	3	4	2	1
16	4	4	4	4	4	4
17	3	4	4	4	4	4

Glare Control in June

Point No	North Glare June Score (OVNI)	East Glare June Score (OVNI)	West Glare June Score (OVNI)	South Glare June Score (OVNI)	Glare June Score (OVNI)	June Glare Sensitivity-Adjusted Score
1	4	4	4	4	4	4
2	4	4	4	4	4	4
3	3	4	4	4	4	4
4	4	4	3	4	4	4
5	3	4	1	1	2	1
6	3	4	1	1	2	1
7	2	4	1	1	2	1
8	1	4	1	1	2	1
9	1	1	1	4	2	1
10	3	4	1	4	3	2
11	4	4	4	4	4	4
12	4	4	4	3	4	4
13	4	4	4	4	4	4
14	4	4	4	4	4	4
15	4	4	4	4	4	4
16	4	4	4	4	4	4
17	4	4	4	4	4	4

APPENDIX 7.2 – Daylighting Scores for Witomino

Note:

In this study, glare discomfort at each measurement point was quantified using a scale of 1 to 4 from four cardinal directions according to the OVNI. To incorporate both overall visual comfort and sensitivity to extreme glare conditions, the researcher computed the average glare score per point and applied a penalty of one point if any directional glare score indicated severe discomfort (score = 1). This approach balances sensitivity to localized intense glare with a robust aggregate measure of typical glare exposure. Applying the penalty once per point prevents over-penalization due to multiple glare incidences that may occur at different times or directions, thus reflecting realistic occupant experience without excessive bias.

	Daylight Provision (OVNI)				UDI			
Point No	DP annual	Dec DP	March DP	June DP	UDI Annual Score (OWL grid)	UDI Dec Score (OWL grid)	UDI March Score (OWL grid)	UDI June Score (OWL grid)
1	1	1	1	1	3	1	4	4
2	4	2	4	4	2	4	1	1
3	1	1	1	1	3	1	3	4
4	1	1	1	1	3	1	3	4
5	4	1	4	4	1	4	4	1
6	4	1	4	4	1	4	4	1
7	4	3	4	4	2	4	1	1
8	4	3	4	4	2	4	1	1
9	4	1	3	4	3	2	4	2
10	4	2	4	4	1	4	1	1
11	4	2	4	4	1	4	1	1
12	4	2	4	4	1	4	1	1
13	3	1	4	4	4	1	4	4
14	3	1	3	4	4	3	4	4
15	3	1	3	4	4	2	4	4
16	3	1	3	4	4	3	4	4
17	3	1	3	4	4	3	4	4
18	4	1	4	4	4	4	4	3
19	4	1	4	4	4	4	4	4
20	4	2	4	4	1	4	1	1
21	4	2	4	4	1	4	1	1

	Annual Glare Control					
Point No	North Glare Annual Score (OVNI)	East Glare Annual Score (OVNI)	West Glare Annual Score (OVNI)	South Glare Annual Score (OVNI)	Glare Annual Score (OVNI)	Annual Glare Sensitivity-Adjusted Score
1	4	4	4	4	4	4
2	3	4	1	4	3	2
3	4	4	4	4	4	4
4	4	4	4	4	4	4
5	1	4	4	4	3	2
6	1	3	4	4	3	2
7	1	1	1	4	2	1
8	1	1	3	4	2	1
9	3	4	2	4	3	3
10	1	3	1	4	2	1
11	1	4	1	1	2	1
12	1	3	1	4	2	1
13	4	4	3	2	3	3
14	4	4	3	3	4	4
15	4	4	4	4	4	4
16	4	4	1	4	3	2
17	4	4	3	4	4	4
18	4	4	1	3	3	2
19	4	4	1	4	3	2
20	4	4	1	1	3	2
21	2	4	1	4	3	2

Glare Control in December

Point No	North Glare Dec Score (OVNI)	East Glare Dec Score (OVNI)	West Glare Dec Score (OVNI)	South Glare Dec Score (OVNI)	Glare Dec Score (OVNI)	Dec Glare Sensitivity-Adjusted Score
1	4	4	4	4	4	4
2	4	4	4	4	4	4
3	4	4	4	4	4	4
4	4	4	4	4	4	4
5	4	4	4	4	4	4
6	4	4	4	4	4	4
7	3	4	4	4	4	4
8	3	4	4	4	4	4
9	4	4	4	4	4	4
10	3	4	4	4	4	4
11	4	4	4	4	4	4
12	4	4	4	4	4	4
13	4	4	4	4	4	4
14	4	4	4	4	4	4
15	4	4	4	4	4	4
16	4	4	4	4	4	4
17	4	4	4	4	4	4
18	4	4	4	4	4	4
19	4	4	4	4	4	4
20	4	4	4	4	4	4
21	4	4	4	4	4	4

Glare Control in March

Point No	North Glare March Score (OVNI)	East Glare March Score (OVNI)	West Glare March Score (OVNI)	South Glare March Score (OVNI)	Glare March Score (OVNI)	March Glare Sensitivity-Adjusted Score
1	4	4	4	4	4	4
2	4	4	1	4	3	2
3	4	4	4	4	4	4
4	4	4	4	4	4	4
5	1	4	4	4	3	2
6	2	4	4	4	4	4
7	1	3	3	4	3	2
8	1	2	4	4	3	2
9	4	4	2	4	4	4
10	1	4	1	4	3	2
11	1	4	1	1	2	1
12	1	4	1	4	3	2
13	3	4	1	1	2	1
14	4	4	1	1	3	2
15	4	4	3	4	4	4
16	4	4	1	4	3	2
17	4	4	4	4	4	4
18	4	4	1	3	3	2
19	4	4	2	4	4	4
20	3	4	1	1	2	1
21	2	4	1	4	3	2

Glare Control in June

Point No	North Glare June Score (OVNI)	East Glare June Score (OVNI)	West Glare June Score (OVNI)	South Glare June Score (OVNI)	Glare June Score (OVNI)	June Glare Sensitivity-Adjusted Score
1	4	4	4	4	4	4
2	1	4	1	1	2	1
3	4	4	4	4	4	4
4	4	4	4	4	4	4
5	1	3	3	4	3	2
6	1	2	4	4	3	2
7	1	1	1	4	2	1
8	1	1	2	4	2	1
9	3	4	1	4	3	2
10	1	1	1	4	2	1
11	1	3	1	1	2	1
12	1	1	1	4	2	1
13	4	4	4	3	4	4
14	4	4	3	3	4	4
15	4	4	4	4	4	4
16	4	4	1	4	3	2
17	4	4	1	4	3	2
18	4	4	1	3	3	2
19	2	4	1	4	3	2
20	3	4	1	1	2	1
21	1	4	1	3	2	1

APPENDIX 8 – Space Syntax Scores

Maly Kack

Point No	Connectivity Score	Visibility Score
1	1	1
2	4	1
3	3	3
4	3	3
5	4	4
6	4	4
7	4	4
8	4	4
9	4	1
10	4	4
11	3	2
12	4	4
13	4	4
14	4	4
15	4	4
16	4	3
17	4	3

Witomino

Point No	Connectivity Score	Visibility Score
1	4	4
2	4	2
3	4	3
4	4	3
5	1	1
6	1	1
7	1	1
8	1	1
9	3	2
10	3	2
11	3	2
12	3	2
13	4	3
14	4	3
15	4	3
16	3	4
17	3	4
18	3	4
19	2	4
20	3	3
21	2	4

APPENDIX 9.1 – Ranking Table of the Maly Kack Scores

Point No	Connectivity	Connectivity Ranking	Visibility	Visibility Ranking	Glare Sensetive Dec	Glare Sensetive Dec Ranking	Glare Sensetive March	Sensetive March Ranking	Glare Sensetive June	Glare Sensetive June Ranking
1	1	1	1	2	4	9	4	15.5	4	16.5
2	4	11	1	2	4	9	4	15.5	4	16.5
3	3	3	3	6.5	4	9	3.75	12	1	5
4	3	3	3	6.5	4	9	3.75	12	1	5
5	4	11	4	13	4	9	1.25	7	1	5
6	4	11	4	13	4	9	1.25	7	1	5
7	4	11	4	13	4	9	1	5	1	5
8	4	11	4	13	4	9	0.75	2.5	1.25	9
9	4	11	1	2	4	9	0.75	2.5	1	5
10	4	11	4	13	4	9	2	9	1.5	11
11	3	3	2	4	4	9	4	15.5	3.5	15
12	4	11	4	13	4	9	0.75	2.5	2	13.5
13	4	11	4	13	4	9	0.75	2.5	1	5
14	4	11	4	13	4	9	3.5	10	1.5	11
15	4	11	4	13	4	9	1.25	7	0.5	1
16	4	11	3	6.5	4	9	4	15.5	1.5	11
17	4	11	3	6.5	4	9	3.75	12	2	13.5

APPENDIX 9.1 – Ranking Table of the Maly Kack Scores

Point No	Glare Average Dec	Average Dec Ranking	Glare Average March	Average March Ranking	Glare Average June	Glare Average June Ranking	UDI Dec	UDI Dec Ranking	UDI March	UDI March Ranking
1	4	9	4	15.5	4	16.5	1	1.5	4	14.5
2	4	9	4	15.5	4	16.5	3	4.5	4	14.5
3	4	9	3.75	12	1	2	4	11.5	2	6.5
4	4	9	3.75	12	1	2	4	11.5	2	6.5
5	4	9	2.25	7	2	6.5	4	11.5	3	10
6	4	9	2.25	7	2	6.5	4	11.5	3	10
7	4	9	2	5	2	6.5	4	11.5	2	6.5
8	4	9	1.75	2.5	2.25	9	4	11.5	1	2.5
9	4	9	1.75	2.5	2	6.5	4	11.5	1	2.5
10	4	9	3	9	2.5	11	4	11.5	4	14.5
11	4	9	4	15.5	3.5	15	3	4.5	4	14.5
12	4	9	1.75	2.5	3	13.5	4	11.5	2	6.5
13	4	9	1.75	2.5	1	2	1	1.5	1	2.5
14	4	9	3.5	10	2.5	11	4	11.5	3	10
15	4	9	2.25	7	1.5	4	4	11.5	1	2.5
16	4	9	4	15.5	2.5	11	2	3	4	14.5
17	4	9	3.75	12	3	13.5	4	11.5	4	14.5

APPENDIX 9.1 – Ranking Table of the Maly Kack Scores

Point No	UDI June	UDI June Ranking	DP Dec	DP Dec Ranking	DP March	DP March Ranking	DP June	DP June Ranking	Movement Intensity Dec	Movement Intensity Dec Ranking
1	4	16	1	6.5	1	2	1	2	4	16.5
2	4	16	1	6.5	3	4	3	4	1	8
3	1	5	3	14.5	4	11	4	11	4	16.5
4	1	5	3	14.5	4	11	4	11	3	15
5	2	11	1	6.5	4	11	4	11	2	13
6	2	11	1	6.5	4	11	4	11	0	2.5
7	1	5	1	6.5	4	11	4	11	1	8
8	1	5	3	14.5	4	11	4	11	1	8
9	1	5	3	14.5	4	11	4	11	2	13
10	3	13.5	1	6.5	4	11	4	11	2	13
11	4	16	1	6.5	1	2	1	2	1	8
12	1	5	1	6.5	4	11	4	11	1	8
13	1	5	1	6.5	1	2	1	2	0	2.5
14	2	11	1	6.5	4	11	4	11	1	8
15	1	5	4	17	4	11	4	11	0	2.5
16	3	13.5	1	6.5	4	11	4	11	0	2.5
17	1	5	1	6.5	4	11	4	11	1	8

APPENDIX 9.1 – Ranking Table of the Maly Kack Scores

Point No	Movement Intensity March	Movement Intensity March Ranking	Movement Intensity June	Movement Intensity June Ranking	Spatial Efficacy Dec	Spatial Efficacy Dec Ranking	Spatial Efficacy March	Spatial Efficacy March Ranking	Spatial Efficacy June	Spatial Efficacy June Ranking
1	2	13	3	15	4	16.5	4	15	4	15
2	2	13	3	15	3	11.5	3	10.5	3	10
3	4	17	4	17	4	16.5	4	15	4	15
4	2	13	3	15	3	11.5	4	15	4	15
5	2	13	1	7	3	11.5	4	15	3	10
6	1	7	2	12.5	2	5.5	1	3	4	15
7	1	7	1	7	3	11.5	3	10.5	2	6
8	1	7	1	7	3	11.5	2	7	3	10
9	1	7	1	7	3	11.5	3	10.5	3	10
10	0	2	1	7	1	2	1	3	1	2.5
11	3	16	2	12.5	3	11.5	4	15	4	15
12	2	13	1	7	2	5.5	1	3	2	6
13	1	7	1	7	1	2	1	3	1	2.5
14	1	7	1	7	1	2	3	10.5	3	10
15	1	7	0	1.5	2	5.5	2	7	1	2.5
16	0	2	1	7	3	11.5	1	3	2	6
17	0	2	0	1.5	2	5.5	2	7	1	2.5

Spearman's Ranking Correlation for Maly Kack

		Syntax		Daylight												Behavior					
	Variables	CON	VIS	GSC-D	GSC-M	GSC-J	GCA-D	GCA-M	GCA-J	UDI-D	UDI-M	UDI-J	DP-D	DP-M	DP-J	MI-D	MI-M	MI-J	SE-D	SE-M	SE-J
Syntax	CON		0.5427		-0.55541	-0.20303		-0.55541	-0.036841	0.2919661	-0.20263	-0.22351	-0.17818	0.41964	0.419643	-0.60583	-0.66873	-0.7194	-0.6175	-0.6983	-0.6983
	VIS				-0.62953	-0.46089		-0.62953	-0.387487	0.4507732	-0.38412	-0.36304	-0.07389	0.43781	0.437808	-0.40825	-0.32746	-0.4978	-0.6249	-0.49661	-0.43904
Daylight	GSC-D																				
	GSC-M																0.22585			0.41167	
	GSC-J																	0.21697			0.102244
	GCA-D																				
	GCA-M																0.22585			0.41167	
	GCA-J																	0.04318			0.026322
	UDI-D															0.18894			-0.1991		
	UDI-M																-0.04287			0.09282	
	UDI-J																	0.3878			0.304756
	DP-D															0.20485			0.27268		
	DP-M																-0.37965			-0.22079	
	DP-J																	-0.3939			-0.22079

APPENDIX 9.2 – Ranking Table of the Witomino Scores

Point No	Connectivity	Connectivity Ranking	Visibility	Visibility Ranking	Glare Sensetive Dec	Glare Sensetive Dec Ranking	Glare Sensetive March	Sensetive March Ranking	Glare Sensetive June	Glare Sensetive June Ranking
1	4	18	4	18.5	4	11	4	19.5	4	19.5
2	4	18	2	7	4	11	2.25	12	0.75	3.5
3	4	18	3	12.5	4	11	4	19.5	4	19.5
4	4	18	3	12.5	4	11	4	19.5	4	19.5
5	1	2.5	1	2.5	4	11	2.25	12	1.75	10
6	1	2.5	1	2.5	4	11	3.5	15	1.75	10
7	1	2.5	1	2.5	4	11	1.75	8	0.75	3.5
8	1	2.5	1	2.5	4	11	1.75	8	1	6
9	3	10.5	2	7	4	11	3.5	15	2	12.5
10	3	10.5	2	7	4	11	1.5	5	0.75	3.5
11	3	10.5	2	7	4	11	0.75	1	0.5	1
12	3	10.5	2	7	4	11	1.5	5	0.75	3.5
13	4	18	3	12.5	4	11	1.25	2.5	3.75	17
14	4	18	3	12.5	4	11	1.5	5	3.5	16
15	4	18	3	12.5	4	11	3.75	17	4	19.5
16	3	10.5	4	18.5	4	11	2.25	12	2.25	14.5
17	3	10.5	4	18.5	4	11	4	19.5	2.25	14.5
18	3	10.5	4	18.5	4	11	2	10	2	12.5
19	2	5.5	4	18.5	4	11	3.5	15	1.75	10
20	3	10.5	3	12.5	4	11	1.25	2.5	1.25	7.5
21	2	5.5	4	18.5	4	11	1.75	8	1.25	7.5

APPENDIX 9.2 – Ranking Table of the Witomino Scores

Point No	Glare Average Dec	Average Dec Ranking	Glare Average March	Average March Ranking	Glare Average June	Glare Average June Ranking	UDI Dec	UDI Dec Ranking	UDI March	UDI March Ranking
1	4	11	4	19.5	4	19.5	1	2.5	4	16
2	4	11	3.25	12	1.75	3.5	4	15.5	1	4.5
3	4	11	4	19.5	4	19.5	1	2.5	3	9.5
4	4	11	4	19.5	4	19.5	1	2.5	3	9.5
5	4	11	3.25	12	2.75	10	4	15.5	4	16
6	4	11	3.5	15	2.75	10	4	15.5	4	16
7	4	11	2.75	8	1.75	3.5	4	15.5	1	4.5
8	4	11	2.75	8	2	6	4	15.5	1	4.5
9	4	11	3.5	15	3	12.5	2	5.5	4	16
10	4	11	2.5	5	1.75	3.5	4	15.5	1	4.5
11	4	11	1.75	1	1.5	1	4	15.5	1	4.5
12	4	11	2.5	5	1.75	3.5	4	15.5	1	4.5
13	4	11	2.25	2.5	3.75	17	1	2.5	4	16
14	4	11	2.5	5	3.5	16	3	8	4	16
15	4	11	3.75	17	4	19.5	2	5.5	4	16
16	4	11	3.25	12	3.25	14.5	3	8	4	16
17	4	11	4	19.5	3.25	14.5	3	8	4	16
18	4	11	3	10	3	12.5	4	15.5	4	16
19	4	11	3.5	15	2.75	10	4	15.5	4	16
20	4	11	2.25	2.5	2.25	7.5	4	15.5	1	4.5
21	4	11	2.75	8	2.25	7.5	4	15.5	1	4.5

APPENDIX 9.2 – Ranking Table of the Witomino Scores

Point No	UDI June	UDI June Ranking	DP Dec	DP Dec Ranking	DP March	DP March Ranking	DP June	DP June Ranking	Movement Intensity Dec	Movement Intensity Dec Ranking
1	4	17	1	7	1	2	1	2	0	7.5
2	1	5.5	2	16.5	4	15	4	12.5	0	7.5
3	4	17	1	7	1	2	1	2	0	7.5
4	4	17	1	7	1	2	1	2	0	7.5
5	1	5.5	1	7	4	15	4	12.5	0	7.5
6	1	5.5	1	7	4	15	4	12.5	0	7.5
7	1	5.5	3	20.5	4	15	4	12.5	0	7.5
8	1	5.5	3	20.5	4	15	4	12.5	0	7.5
9	2	11	1	7	3	6	4	12.5	1	17.5
10	1	5.5	2	16.5	4	15	4	12.5	1	17.5
11	1	5.5	2	16.5	4	15	4	12.5	1	17.5
12	1	5.5	2	16.5	4	15	4	12.5	1	17.5
13	4	17	1	7	4	15	4	12.5	0	7.5
14	4	17	1	7	3	6	4	12.5	0	7.5
15	4	17	1	7	3	6	4	12.5	1	17.5
16	4	17	1	7	3	6	4	12.5	1	17.5
17	4	17	1	7	3	6	4	12.5	0	7.5
18	3	12	1	7	4	15	4	12.5	0	7.5
19	4	17	1	7	4	15	4	12.5	0	7.5
20	1	5.5	2	16.5	4	15	4	12.5	4	21
21	1	5.5	2	16.5	4	15	4	12.5	0	7.5

APPENDIX 9.2 – Ranking Table of the Witomino Scores

Point No	Movement Intensity March	Movement Intensity March Ranking	Movement Intensity June	Movement Intensity June Ranking	Spatial Efficacy Dec	Spatial Efficacy Dec Ranking	Spatial Efficacy March	Spatial Efficacy March Ranking	Spatial Efficacy June	Spatial Efficacy June Ranking
1	1	10	1	14.5	2	13	3	16.5	4	19.5
2	1	10	0	6	1	5	1	4	3	15.5
3	1	10	0	6	2	13	3	16.5	4	19.5
4	1	10	0	6	1	5	2	10.5	2	11
5	2	16.5	2	19.5	1	5	2	10.5	2	11
6	0	3	0	6	2	13	3	16.5	1	4.5
7	1	10	1	14.5	1	5	1	4	3	15.5
8	0	3	0	6	4	19.5	3	16.5	3	15.5
9	1	10	0	6	1	5	1	4	1	4.5
10	2	16.5	0	6	2	13	3	16.5	2	11
11	3	19.5	2	19.5	4	19.5	3	16.5	2	11
12	2	16.5	1	14.5	4	19.5	4	20.5	4	19.5
13	1	10	1	14.5	3	17	2	10.5	1	4.5
14	1	10	1	14.5	1	5	1	4	1	4.5
15	2	16.5	0	6	1	5	1	4	1	4.5
16	4	21	1	14.5	1	5	1	4	1	4.5
17	3	19.5	0	6	1	5	1	4	1	4.5
18	1	10	2	19.5	2	13	2	10.5	3	15.5
19	0	3	0	6	2	13	2	10.5	1	4.5
20	0	3	2	19.5	4	19.5	4	20.5	4	19.5
21	0	3	0	6	2	13	2	10.5	2	11

Spearman's Ranking Correlation for Witomino

		Syntax		Daylight												Behavior					
	Variables	CON	VIS	GSC-D	GSC-M	GSC-J	GCA-D	GCA-M	GCA-J	UDI-D	UDI-M	UDI-J	DP-D	DP-M	DP-J	MI-D	MI-M	MI-J	SE-D	SE-M	SE-J
Syntax	CON		0.3953		0.207633	0.577978		0.207633	0.5779781	-0.714809	0.180522	0.695469	-0.40866	-0.58531	-0.49693	0.00537	0.10781	-0.1503	-0.1254	-0.1631	0.004752
	VIS				0.286576	0.529115		0.286576	0.5291133	-0.381441	0.384683	0.681385	-0.46205	-0.40762	-0.24403	-0.08092	0.03076	-0.0007	-0.068	-0.18332	-0.13971
	GSC-D																				
	GSC-M																0.01345			-0.28417	
	GSC-J																	-0.1548			-0.27499
	GCA-D																				
	GCA-M																0.01345			-0.28417	
	GCA-J																	-0.1548			-0.27499
	UDI-D															0.09776			0.31346		
	UDI-M																0.134			-0.41484	
	UDI-J																	-0.1561			-0.38933
	DP-D															0.21799			0.41372		
	DP-M																-0.25139			0.27981	
Daylight	DP-J																	0.16054			-0.24635

Gdańsk, Apr 2026

- End of the Doctoral Dissertation -