Advancing Indoor Environments

Optimising Integration Of Health-Centric Design Strategies for Indoor Office Environments In The Netherlands.

TU Delft | Deerns

Advancing Workplace Well-being:

Optimising Integration of health-centric design strategies for indoor office environments in the Netherlands

by

Maitri V Kallur
5852080

In partial fulfilment of the requirements for the degree of
Master of Science in Construction Management and Engineering at the Delft University of Technology

In collaboration with Deerns Nederland BV

An electronic version of this thesis is available at
http://repository.tudelft.nl/.

GRADUATION COMMITTEE

Chair:	Dr.Ir. A (Ad) Straub, Associate Professor, Faculty of Architecture and the Built Environment
First Supervisor:	Dr.K.(Queena) Qian, Associate Professor, Faculty of Architecture and the Built Environment
Second Supervisor:	Dr.E.J.(Erik-Jan) Houwing, Assistant Professor, Faculty of Civil Engineering and Geo Sciences
Company Supervisor-1:	Ir. Vyshali Simhachalam, Consultant in Sustainability and Healthy Buildings, Deerns Nederland BV
Company Supervisor-2:	Ir. Lorena Montenegro, Senior Sustainability and well-being consultant, Deerns Nederland BV

Preface

As I approach the completion of my Masters program at TU Delft, I want to express my deepest gratitude to the remarkable individuals who have supported and guided me throughout this journey. First, I am thankful to Ir. Vyshali Simhachalam and Ir Lorena Montenegro of Deerns Nederland BV for not only providing me with an invaluable opportunity but also for offering expert guidance on the technical aspects of my thesis. Additionally, I am indebted to Dr.Ir. A (Ad) Straub, Dr.K.(Queena) Qian and Dr.E.J.(Erik-Jan) Houwing for their support and constructive feedback throughout the project.

I am immensely grateful to my parents and my family for their unwavering trust in me and for encouraging me to pursue new opportunities. I am thankful to God for placing me amidst such wonderful and compassionate individuals during this journey. I wish them the best.

Executive Summary

This study examines the growing need for healthier office environments that improve employee well-being and organizational effectiveness, with a special emphasis on the Dutch context. As awareness of the relevance of healthy workplaces grows, there is an urgent need for a tailored approach that bridges the gap between the global WELL Building Standard and the specific legislative and cultural environment of the Netherlands.

Research Problems and Objectives: The study reveals an important problem: while the WELL Building Standard provides a strong foundation for promoting health and well-being in office buildings, its implementation in the Netherlands needs careful adaptation. The Dutch building code (BBL) specifies the basic criteria, but more thorough and context-sensitive procedures are required to produce really healthy workplace environments. This study intends to provide a tailored framework that combines the WELL Standard's strengths with the specific needs of Dutch office buildings, allowing for the effective implementation of well-being measures during the design and construction phases.

Methodology: To achieve its goals, the study used a mixed-method approach that included a thorough literature review, semi-structured interviews with key stakeholders such as architects, MEP engineers, and well-being consultants, as well as a comparison of existing guidelines such as WELL, BBL with other guidelines in use in the Netherlands. These techniques provided both theoretical and practical insights, assisting in the identification of key performance indicators (KPIs) appropriate to the Dutch context, as well as the problems that professionals encounter when implementing well-being programs in office buildings.

Key Findings: The study discovered that the concept of a healthy office building is extremely subjective, with different stakeholders emphasizing different aspects such as air quality, thermal comfort, and individual control. The WELL Standard, while thorough, requires adaptation to better fit Dutch workplace surroundings, particularly in terms of air quality and thermal comfort. Furthermore, the study emphasized the administrative overhead of the WELL certification process, indicating the need for a more simplified approach that is less resource-intensive and better aligned with local needs.

The personalized framework established as a result of this research includes core components crucial to occupant health and well-being, such as air quality, visual comfort, thermal comfort, acoustic comfort, water, safety, biophilia, spatial quality, personal control and accessibility . It allows you to choose KPIs that are relevant to specific projects while still having some statutory requirements for a healthy indoor environment. The framework is intended to guide project teams and consultants through each stage of an office building project, connecting design considerations with Dutch rules

and contextual requirements.

Practical Implications and Recommendations: The framework is a useful tool for consultants and project teams in setting and achieving well-being goals specific to the Dutch context. It reduces the time and money required to comply with existing criteria while also providing an organized way to include well-being concepts early in the design process, improving occupant happiness and indoor environmental quality.

The study suggests that consulting firms, such as Deerns Nederland BV, educate their clients on the advantages of a bespoke strategy over standard certifications, highlighting the long-term benefits of context-specific well-being objectives. It also proposes that further research be conducted into the costs of implementing well-being policies to enhance the business case for healthier workplaces. Encouraging customers to incorporate frequent occupant surveys into their well-being initiatives, as well as focusing on the restoration of existing buildings for health and sustainability retrofits, are additional essential recommendations that will widen the framework's impact.

This study makes major contributions to the field by introducing a novel, context-specific approach for building healthy office settings in the Netherlands. By addressing the shortcomings of existing recommendations such as WELL and tailoring them to local conditions, the framework offers a solution that improves both health outcomes and organizational effectiveness. The findings highlight the necessity of incorporating stakeholder perspectives and adjusting global standards to match local demands, which will ultimately aid in the establishment of healthier, more productive workplace spaces.

Contents

List of Tables

List of Figures

1

Introduction

1.1 Background

Our never-ending quest for novel and improved approaches to enhance our health and wellness is one thing that has stayed constant throughout our attempts to tackle the different challenges faced in modern daily living. As we strive for better health, we often emphasize leading a healthy lifestyle that includes regular exercise, a balanced diet, and perhaps giving up bad habits like smoking. Nevertheless, given that we spend 90% of our time indoors, mostly in our homes and workplaces, an equally significant aspect that is overlooked in the discussions about healthy lifestyles that are currently receiving much more attention is the impact of our built environments, particularly our homes and workplaces, on our overall well-being (Jensen & Van Der Voordt, 2019).

Studies have also demonstrated that, in addition to natural environmental challenges resulting from climate change, a major influencing factor on people's health is the risk of a home environment, which majorly includes indoor environmental pollution in buildings (Liu, Xu, Tam, & Mao, 2023). As a result, these surroundings have an outsized impact on our health and can either help or hinder our attempts at maintaining a healthy lifestyle. While poorly planned places might result in declining health and higher stress levels, well-designed surroundings can encourage healthy habits and decision-making. The built environment influences health and well-being because it shapes lifestyles. Buildings such as schools, hospitals, offices, and social areas can be designed with this in mind to foster social connections, healing, learning, and increased productivity in workplaces, all of which have long-term developmental advantages. In contrast, poor design can impede mobility and interaction, creating discomfort and stress. Recognizing these effects, particularly in light of recent viral outbreaks such as COVID-19, there is a growing emphasis on developing healthier indoor settings (Jensen & Van Der Voordt, 2019; Liu et al., 2023).

1.2 Introduction

The concept of "healthy buildings" goes beyond merely preventing illness and includes spaces promoting physical, psychological, and social well-being. These buildings provide secure, comfortable spaces that improve health, reduce stress, and encourage positive social connections. Air quality, lighting, and access to nature are a few of the critical components that support the occupant well-being (Emmitt, 2022; Liu et al., 2023; Marberry, Guenther, & Berry, 2022).

The impact of indoor environments on physical and mental health became increasingly noticeable. It gained awareness, particularly during and after the COVID-19 pandemic (Jensen & Van Der Voordt, 2019; Liu et al., 2023) As people spent more time indoors during the COVID-19 pandemic. The interaction with the indoor environment was then more than ever, which is why the physical and mental health effects became increasingly noticeable. The pandemic highlighted the importance of indoor environment quality and occupant health and satisfaction, leading to a more focused discussion about the role of built environments in promoting overall health. This discussion also gained more attraction in the context of office buildings since one-third of European employees work in an office building for an average of 8 hours each day, accounting for a sizable chunk of their indoor time (2030 & BPIE, 2018; AnniWeiler, 2004). By designing office buildings with a health-centric focus, companies may create a more encouraging and productive atmosphere that improves worker performance and well-being. An office designed with a health-centric focus necessarily aims for occupant health and well-being in the indoor office environment.

1.3 Influence of Healthy Workplaces on Employee Well-Being and Productivity

The advantages of a healthy work environment are numerous and affect corporate productivity and employee well-being. Empirical studies have consistently indicated that improving office space conditions significantly enhances staff health and work performance (T. Van Der Voordt & Jensen, 2021).

Improved Employee Satisfaction and Well-Being
Healthy workplaces enhance overall well-being and minimize stress, both boosting employee satisfaction. There is a positive correlation between employee engagement and job happiness in well-maintained and thoughtfully designed facilities. This enhanced satisfaction is critical for creating a positive work environment and lowering turnover rates (Palacios, Eichholtz, & Kok, 2020).

Enhanced Productivity and Reduced Absenteeism
Productivity growth is one of the most noticeable advantages of healthy work environments. Employees in such workplaces report relatively fewer health concerns, including headaches and respiratory problems, which are frequent in poorly maintained areas. Lower absenteeism and fewer sick days directly correlate with decreasing these symptoms, allowing workers to retain greater performance levels and consistent attendance (Horr et al., 2016; Palacios et al., 2020).

Economic Benefits and Cost Efficiency
Investments in healthy workplaces result in considerable savings from an economic standpoint. Organizations benefit from lower absenteeism and turnover rates, which, along with increased productivity, can outweigh the initial expenditures for upgrading office spaces. Economic benefits include lower healthcare expenditures and staff turnover rates, resulting in long-term financial stability for businesses (T. Van Der Voordt & Jensen, 2021).

Addressing Sick Building Syndrome (SBS)
Maintaining a healthy workforce requires dealing with problems like sick building syndrome (SBS), which can cause headaches and irritated eyes. Organizations may ensure a healthy workforce by lowering the prevalence of SBS, which leads to higher morale and fewer health-related work disruptions. The improvement of employee well-being directly impacts increased output and satisfaction, both of which are essential for achieving company objectives (Horr et al., 2016).

1.4 Current Approaches to Healthy Office Buildings in the Netherlands

In the Dutch (AEC) industry, the significance of healthy office buildings is steadily growing. For competitive markets trying to engage employees, attract and retain talent, and boost productivity, building selection has been one of the most important considerations (Institute et al., 2017). The benefits of healthy work environments for employee well-being and organizational objectives are getting more widely acknowledged by office owners. Global investment strategy highlights that the leaders integrating health and well-being strategies internally or externally are increasing too (Institute et al., 2017). As a result of this realization, Dutch business owners are increasingly prioritizing the creation of healthy work environments. An exploratory interview was conducted with a well-being expert in the Dutch AEC sector to understand this trend better. According to the interview, a common strategy for creating healthy working settings is to pursue various certifications, like the WELL Building Standard, widely chosen to achieve well-being goals. Furthermore, organizations' larger sustainability and well-being goals sometimes include certifications like BREEAM; however, WELL is especially renowned for its emphasis on optimizing occupant productivity and happiness.

The US-developed WELL Building Standard is a performance-based system that measures, certifies, and monitors elements of the built environment that impact people's health and well-being. It acts as a guideline that helps form a vision for a building project that supports people's health and well-being. It gives methods for achieving "health-first" factors that improve physical and mental health, helping occupants perform their best work in a comfortable environment (Well, n.d.).

1.5 Application and Adoption of existing WELL building guideline

The WELL Building Standard in companies in the Dutch AEC industry are implementing WELL certifications that are evaluated against ten fundamental concepts. Each concept targets certain components of the built environment that affect health and well-being. This certification is a health and well-being benchmark and a framework for firms to adopt health-centric design aspects (Well, n.d.). The standard's approach to health and well-being appeals to companies looking to improve employee happiness and productivity, directly related to better organizational outcomes.
However, depending on regional conditions, such as local laws, cultural norms, and environmental concerns, the application of WELL and related worldwide standards might differ. The rise of interest in certifications like WELL reflects an increased understanding of the importance of workplace health and well-being, including the need for standards that may be customized to local situations. This discussion sets up the context for exploring the limitations of present global standards and the need to design a more specific strategy for the Dutch environment, which will be addressed in the problem description section.
The shift towards healthier work environments is an essential evolution in building design that promotes employee well-being and productivity. It is necessary to incorporate a proactive approach that targets pressing health issues and anticipates future demands, assuring that office buildings continue to be significant assets that encourage organizational success. The emphasis on developing healthier indoor environments also aligns with UN Sustainable Development Goal 3 (SDG 3), which seeks to ensure healthy lifestyles and promote well-being for all ages (*THE 17 GOALS | Sustainable Development*, n.d.). Therefore, developing healthier indoor work environments extends to understanding and analysing what influences forming healthier indoor environments (Council, 2022). By analyzing this, the study seeks to encourage the creation of office environments that improve occupant health and productivity and thus contribute to broader public health and sustainable development goals.

1.6 Problem Definition

As the importance of integrating healthy building practices in office environments becomes increasingly recognized, the WELL Building Standard has emerged as a widely adopted framework focused on promoting occupant health and productivity. However, its full applicability to Dutch office buildings is not entirely optimal due to regulatory, environmental, and cultural differences that may not align with the specific needs of the Dutch context. While providing a foundation for health considerations, the Dutch building code is often considered the minimum standard, necessitating more stringent measures to create healthy office environments. Furthermore, the administrative burden and focus on certification rather than genuine well-being improvements highlight the need for a tailored approach. This research seeks to address these challenges by developing a context-specific framework that bridges the gap between the Dutch building code and the WELL guidelines, ensuring that well-being goals are effectively integrated into the design and construction of Dutch office

buildings.

1.6.1. Research Objective

This project aims to facilitate the design and development of new, healthy office buildings that maximize occupant satisfaction, lower absenteeism, boost worker productivity and promote a positive work culture and environment. This study intends to assist consultants and project teams in the companies to create office environments that align with specific needs and corporate well-being goals. The study will focus on:

1. **Understanding Healthy Office Buildings:** Examining what makes an office building healthy and how these settings benefit companies and their occupants.
2. **Identifying Major Influential Elements:** Determining which office environment features—like lighting, ergonomics, air quality, and social areas- significantly impact inhabitants' satisfaction and general well-being.
3. **Determining and Choosing Effective Indicators:** Establishing a health and well-being strategy in office settings by identifying the most important key performance indicators that can be used to assess and achieve optimal levels of the identified factors, which have a significant impact on occupant satisfaction and overall well-being.
4. **Stakeholder perspectives:** Engaging with various stakeholders, such as employees, employers, architects, well-being experts, etc., to gather diverse perspectives and insights into a healthy office environment. This will aid in understanding the specific needs and preferences of various groups.
5. **Understanding Challenges:** The research intends to analyze the problems that project teams, consultants, and stakeholders experience when integrating health and well-being strategies into designing and constructing new office buildings.
6. **Developing approaches to tackle these challenges:** The ultimate objective is to create a feasible approach that assists project teams in tackling the problems identified for incorporating well-being techniques into office building design.

By including these components, the study seeks to offer a thorough framework that promotes the development of healthy work environments, ensuring that the layout and functionality of these areas improve employees' productivity and well-being while being sensitive to the unique circumstances of Dutch office buildings.

1.6.2. Research Scope

This thesis investigates the idea of healthy office buildings specifically in the Dutch context. The study underscores the significance of incorporating health-centred approaches from the early design stages of brief preparation till design considerations for construction and handover stages of a new office building project to guarantee that these factors remain embedded in the project's goals and vision. This strategy adds to the value of the company's portfolio while also improving occupant well-being, which makes it particularly important for the construction of new office buildings. Key aspects of the research scope are as follows:

1. **New construction:** There is a huge opportunity to integrate health-focused design concepts

from the beginning because a large portion of the infrastructure for the future—roughly three-quarters of the infrastructure that will exist in 2050—has not yet been built. Taking a proactive stance ensures that new construction is designed with occupants' and organizations' long-term well-being in mind. Renovation projects were excluded from this study due to the complexities of retrofitting existing structures to meet modern health and well-being standards. These projects often face limitations such as structural constraints, outdated systems, and the need for extensive modifications, which can significantly affect the feasibility and effectiveness of implementing comprehensive health and well-being strategies within the existing built environment.

2. **Design Considerations:** The study identifies several design factors that should be considered at different phases of creating a healthy office building. This comprehensive approach guarantees the integration of health and well-being throughout the building's development, from the initial design phase to the validation of achieved well-being levels. The study, however, does not include the maintenance or operation stages of the building. This procedure involves setting clear well-being targets and evaluating the building's performance.
3. **Owner-Occupied Offices:** The focus on owner-occupied office spaces is due to owners' greater influence over long-term design decisions, allowing for a more cohesive approach to integrating well-being strategies. In contrast, leased spaces involve multiple stakeholders, which can complicate decision-making processes and limit the ability to implement comprehensive health and well-being measures.

1.6.3. Research Questions:

To effectively direct the exploration of the different topics addressed in this research, the study asks the following main and sub-research questions:

Main Research Question:

How to effectively integrate well-being into the design and construction of office buildings to enhance indoor environmental quality and occupant satisfaction?

Sub-Research Questions

1. What is a healthy office building and what does it consist of?
2. What are the current practices related to healthy office buildings in the Netherlands? What standards are in use, and how are they implemented across project phases, including the roles of different stakeholders?
3. What are the challenges in integrating health and well-being strategies in new office buildings?
4. How and what kind of approach can help tackle these challenges?

2

Research Methodology

This study adopts a qualitative approach, highlighting the gathering and examining of non-numeric data to comprehend concepts, opinions, and experiences. This methodology is well-suited for comprehending particular issues or producing novel concepts for study (*Bhandari, P. (2020) What is Qualitative Research Methods*, 2020). The approaches are created to systematically address the study objectives, progressing from fundamental insights gained from literature to practical implementations and stakeholders' perspectives.

2.1 Literature study

The research starts with analysing existing literature to comprehend the characteristics that define a healthy office building. This review highlights important factors, including air quality, thermal comfort, lighting, acoustics, and access to nature, that enhance health, well-being, and productivity in office environments. However, the research also indicates gaps in understanding the subjective nature of well-being goals and how stakeholders define and prioritize them in real-world projects in the Dutch Context.

Although literature offers a solid theoretical basis, it is acknowledged that a practical perspective is necessary to address specific contextual requirements in the industry. This practical approach is essential for examining the subjective aspects of healthy office buildings, comprehending how well-being objectives are defined within the industry, and identifying the obstacles encountered during implementation. Hence, employing additional approaches to obtain primary data from those directly engaged in creating healthy office buildings is important.

An effective approach for this purpose is conducting semi-structured interviews, which are employed to obtain valuable insights into existing procedures, practices, challenges, and other relevant aspects. Additionally, surveys are an excellent method to acquire quick, comparable insights regarding priorities within the study subject (Jones, Baxter, & Khanduja, 2013). This study aims to utilize surveys to investigate the preferences of stakeholders and occupants regarding the components that contribute to a healthy office building.

After identifying current practices, a more in-depth understanding of regulatory rules such as the Dutch building code and practical guidelines such as WELL are required. The content analysis approach will be applied to comprehend, distinguish, and contrast the variations among these guidelines. Integrating these techniques ensures that the research thoroughly addresses the highlighted gaps in the literature and offers practical, implementable insights tailored to the Dutch office building setting.

2.2 Semi-Structured Interviews

Semi-structured interviews help address the gaps found in literature and gain practical insights because the interview's flexible style allows the researcher to prompt or encourage the interviewee if they want to learn more or find what they're saying intriguing. This strategy allows the researcher to ask the subject to elaborate or to pursue a new line of inquiry inspired by what the interviewee says. Semi-structured interviews also allow informants to voice their opinions in their own words (Barclay, Project, & of Sociology, 2018). This methodology is suitable for investigating the complexities of existing processes, practices, and challenges within the sector. The project aims to explore further the articulation of well-being goals and the unique problems encountered during the implementation of these goals by engaging with stakeholders directly involved in developing and constructing healthy office environments.

- **Objective:** To examine different perspectives about healthy buildings, understand current practices and identify challenges encountered at various project stages.
- **Participants:** Professionals already familiar with the existing method of incorporating well-being into office buildings and participating in different project stages.
- **Research Questions Investigated:** These interviews provide insights into existing practices associated with promoting healthy office buildings (SQ2) and SQ3, which is about the challenges in the current practices for integrating health and well-being strategies into a new office building design and construction.

2.3 Stakeholders and Occupant Survey

Along with the semi-structured interviews, surveys are conducted to get the opinions and perspectives of a wider group of stakeholders, including occupants, as surveys are an effective way to obtain quick, comparable insights into priorities within the study subject Jones et al. (2013). These studies could offer important insights into the subjective aspects of well-designed office buildings as experi-

enced and perceived by individuals who use and engage with these spaces. To enhance the alignment between research findings and the needs and expectations of end-users, it is crucial to know the factors that stakeholders prioritise.

- **Objective:** To evaluate stakeholders' opinions and varying priorities about creating healthy office buildings and to measure their understanding of the situation and their views of well-being in office environments.
- **Research Questions Investigated:** The surveys play a key role in understanding the subjectivity of priorities of well-being indicators and SQ4: about what approach can effectively address these challenges found during the study. Collecting the goals and perspectives of stakeholders can then be used to design a customised approach in which the priorities can be taken into account.

2.4 Content Analysis

Content analysis is used to analyze the applicability of current frameworks, such as WELL and Bouwbesluit, to the Dutch setting. An approach like that allows for a thorough examination of textual data by carefully categorizing and analyzing it to find underlying themes and meanings, making it especially effective for comprehending complex phenomena in context. It combines the flexibility of inductive and deductive methodologies, allowing researchers to get rich insights while respecting the iterative character of qualitative research (Gheyle & Jacobs, 2017). This approach includes an analysis of the relevant guidelines to assess and evaluate the indicators and levels indicated, which impact the effectiveness of fundamental elements of a healthy office building. The analysis assesses the extent to which these standards correspond to the requirements of Dutch office buildings and if they offer adequate direction for obtaining the required health and well-being results.

- **Objective:** To understand current Dutch building code requirements, evaluate the widely used WELL framework, and pinpoint important signs and thresholds relevant to the Dutch setting.
- **Research Questions Investigated:** This approach is crucial for addressing SQ2: "What are the current practices regarding healthy office buildings?" It accomplishes this by thoroughly analysing existing standards and their applicability to Dutch office buildings. In addition, it helps to understand the extent of applicability of the existing WELL framework in Dutch office buildings.

2.5 Subsequent Semi-Structured Interviews

A subsequent set of semi-structured interviews will be conducted based on the results of the document analysis. These interviews involve experts with specialised knowledge in specific areas such as lighting, MEP (Mechanical, Electrical, Plumbing), and other fundamental elements. These interviews aim to confirm the key indicators of the foundational element based on their expertise, determine the healthy levels required in the Dutch environment, and highlight important factors at different stages of office building projects. This stage is crucial for creating a customized frame-

work that incorporates optimal methods and is appropriate for the specific context of Dutch office buildings.

- **Objective:** The objective is to verify the indicators chosen for each component of healthy office buildings defined in the initial phase, comprehend the ideal levels required in the Dutch environment, and formulate appropriate indicators and levels for the framework.
- **Research Questions Investigated:** These interviews provide additional insights into addressing SQ3: "What are the challenges in the current integration of health and well-being strategies?" and SQ4: "What kind of approach can help tackle these challenges?" by offering expert insights on individual elements and their ideal levels, thereby suggesting an effective method to tackle them.
- **Subsequent Literature study:** Additionally, for the foundational elements which are not mentioned in the existing frameworks, well-established researchers are looked for to understand their key performance indicators and strategies to implement them and are later validated by health and well-being experts involved in creating healthy office buildings; this method is carried out to address and set up considerations for the elements which are not explicitly mentioned in the existing framework or guidelines.

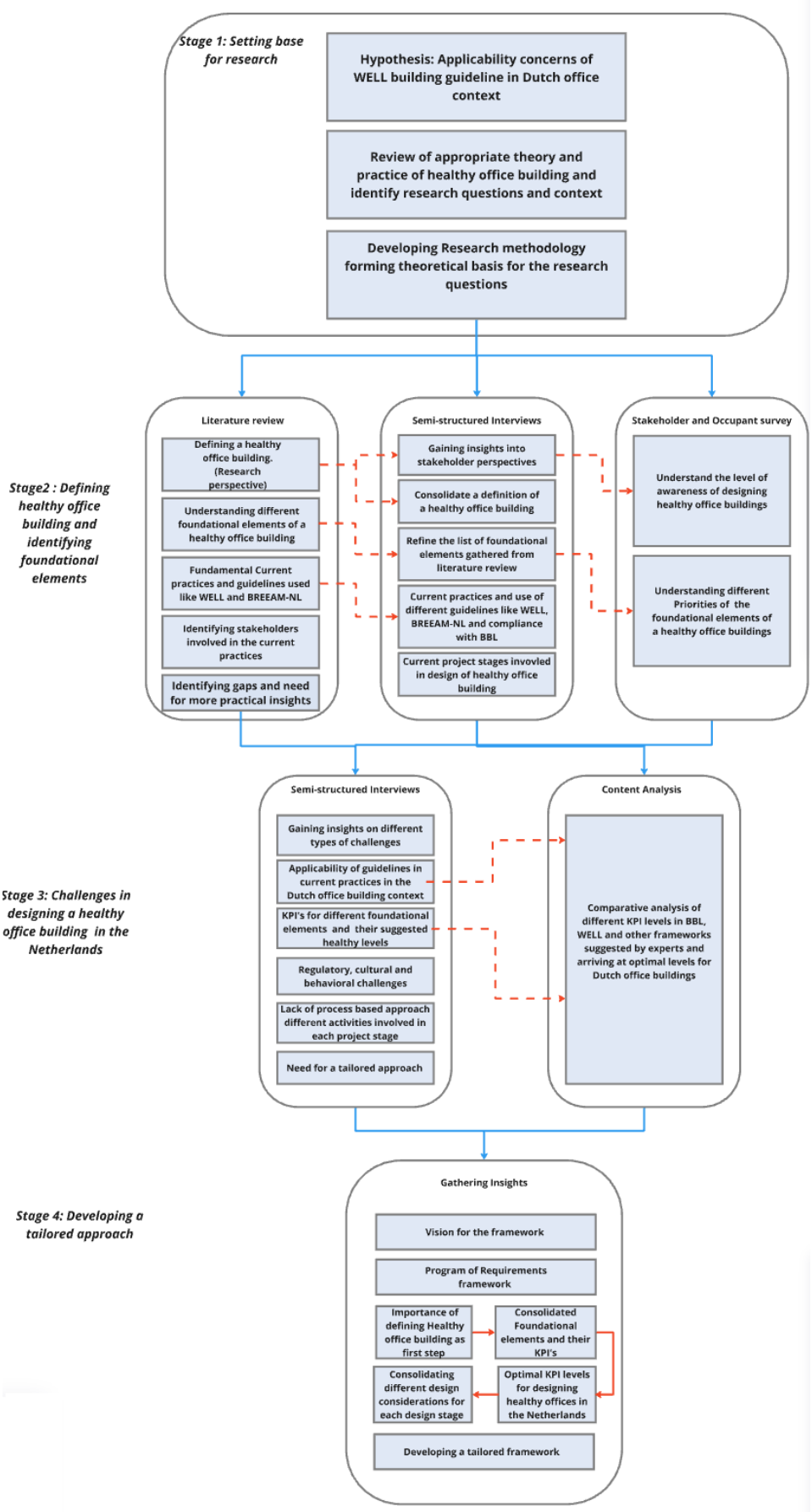


Figure 2.1: Research Methodology

2.6 Data Collection Process

The data collection for this study was carried out in compliance with the code of ethics for academic research involving people who participate. The approach used—semi-structured interviews, surveys, and document and content analysis—were chosen to align with the research objectives, allowing for an exploration (from a practical perspective) of integrating well-being into office environments.

1. **Semi-structured Interviews**
    - Ethical Considerations: All interviews followed ethical guidelines to protect informed consent, confidentiality, and participant rights.
    - **Interviewee Selection Criteria:**
    - Professional Involvement: The chosen professionals actively participated in current practices of creating healthier office environments. Individuals with prior expertise working with certifications such as BREEAM-NL and WELL for office building design (as it was observed in the literature study that these are the common practices in the Netherlands) were picked.
    - Participants: Participants included the key stakeholders such as sustainability and well-being consultant, architect, contractor, corporate real estate representative for well-being, facility manager, MEP designer, lighting designer, and acoustics consultant. These roles were chosen to capture various insights from various project stages.
2. **Surveys:**
    - Respondent Selection Criteria: Involvement in Healthy Office settings: The surveys focused on stakeholders involved in developing healthy office settings, including the same stakeholders questioned and the primary end-user stakeholder: the occupant.
    - Occupant Participation: Office workers were surveyed to learn how they experience and view their workplaces in terms of well-being.
3. **Content Analysis**
    - Document Selection Criteria: Key documents examined were the Dutch building code (Bouwbesluit), WELL, and BREEAM-NL certifications.
    - Additional frameworks: Based on expert recommendations, additional frameworks such as Gezonde Kantoren, NVBV Handbook, NEN 12464, and NEN 1814 were incorporated to analyze various KPIs for the foundational elements of a healthy office building.
    - Comparative Analysis: This method enabled an examination of how these frameworks define and assess different elements of well-being in office settings. KPIs for elements not prominently covered in existing frameworks, such as biophilia, personal control, spatial arrangement, and safety, were found using well-cited research studies. These KPIs were then evaluated through interviews with specialists in several domains, including lighting, MEP design, acoustics, and consultants for well-being.
4. **Validation Interviews:**
    - Interviewee selection basis: Experts chosen for validation interviews had specific knowledge in the areas under consideration, including lighting, MEP design, acoustics, and well-being. This was done to verify that the consolidated KPIs and their numerical levels were complete and strategically linked with the needs of Dutch office buildings.

2.7 Data Analysis Methodology

The data gathered through semi-structured interviews, surveys, and document analysis were analyzed using thematic analysis, a qualitative method used to find, interpret, and describe patterns (themes) in data. The thematic analysis enables a rich, nuanced knowledge of the research's core themes, supporting the development of an approach for incorporating well-being into workplace environments (Nowell, Norris, White, & Moules, 2017).

Thematic Analysis Steps

1. Familiarize with the data.: The initial stage was to fully engage in the obtained data by reviewing interview transcripts, survey responses, and document analysis notes. This technique assisted in detecting initial codes and gaining a thorough grasp of the data. Relevant parts were underlined, and notes were taken on emerging patterns and key points stated by participants.
2. Generating initial codes: The data was carefully coded by identifying relevant portions for the study topics. Each code reflected a data aspect that looked important in understanding how well-being is integrated into office building design. Coding was done manually to ensure that the context was completely captured. Codes were organized into broader categories based on the fundamental aspects of a healthy office building, implementation challenges, and the efficacy of present methods.
3. Searching for themes: After coding was completed, the codes were analyzed to discover probable themes. Themes were determined based on the codes' frequency, relevance to the research objectives, and the amount of data linked with each code.
4. Reviewing Themes: The identified themes were carefully examined to ensure they represented the data and effectively addressed the study questions. This included comparing the themes to the coded data to ensure coherence and consistency.
5. Defining and Naming Themes After the themes were finalized, they were carefully defined and named to reflect their essence and importance to the research. This step involved explaining what each subject represented and how it related to understanding the incorporation of well-being into office environments.
6. Writing an Analysis: The final step involved organizing the findings into a logical flow. The themes concerning the study questions were presented, with illustrative quotes from interviews and surveys to support the interpretation. The findings were then examined in the literature, emphasizing the similarities and differences of previous investigations.

This method helps methodically integrate data, discover common patterns, and generate themes that enable a deeper understanding of qualitative data collected for the project analysis Guest, MacQueen, and Namey (2012).

3

Literature Review

This literature review delves into fundamental components of designing healthy office buildings, including defining a healthy office building, its contextual subjectivity, foundational elements, stakeholder roles, and existing practices and frameworks. The literature study understands the fundamental features involved in standards like WELL and BREEAM-NL, identifying gaps in existing research and setting the context for an effective approach incorporating health and well-being into workplace design within the Dutch environment. This subsection helps form basis to answer the fundamental research questions like **SQ1 and SQ2**.

3.1 Definitions of a Healthy Office Building

Healthy office buildings put occupants' physical and emotional well-being first, encouraging community and social interaction. According to (Barton, Thompson, Burgess, & Grant, 2015; Heidari, Younger, Chandler, Gooch, & Schramm, 2016), these buildings are intended to improve people's general health and quality of life by creating secure and pleasant environments. One of the fundamental features of a healthy building is freedom from harmful elements, pollutants, and hazardous materials, guaranteeing that the indoor environment promotes health rather than compromises it (Holdsworth & Sealey, 1993). These buildings incorporate aspects that improve interior environmental quality (IEQ), such as improved air quality, thermal comfort, lighting, and acoustics, which are important for physical and mental health (Bluyssen, Janssen, Van Den Brink, & De Kluizenaar, 2011).

Green building concepts often align with the concept of healthy buildings, as they seek to create indoor settings that are both healthy and sustainable. To assess how these buildings affect people's health, productivity, and general well-being, it is essential to identify Health Performance Indicators (HPIs) (Allen et al., 2017). These indicators are important when assessing how successfully a

building achieves its health-oriented objectives. According to recent studies, healthy office buildings minimize Sick Building Syndrome (SBS) and enhance overall comfort and satisfaction by optimizing indoor climate and spatial layout, along with incorporating green features. (Colenberg & Jylhä, 2021; Jensen & Van Der Voordt, 2019). These approaches highlight the vital link between occupant well-being and environmental quality.

In addition, the importance of social interactions and stress reduction in healthy office buildings is becoming more widely acknowledged. These factors are critical to overall well-being. These buildings provide a supportive and balanced work environment by encouraging interactions and supporting mental health (Kropman, Appel-Meulenbroek, Bergefurt, & LeBlanc, 2022). The integration of physical, mental, and social well-being into the design and operation of healthy office buildings is emphasized regularly in the literature.

3.2 Subjectivity of the concept of Healthy office buildings

Furthermore, healthy office buildings are subjective and change depending on individual preferences and needs. According to (Christoforou, Lange, & Schweiker, 2024), definitions of health and well-being vary within disciplines and demographics and are impacted by personal traits, beliefs, and priorities. Because various people may prioritize different aspects of health and well-being—such as physical health, mental health, social relationships, or environmental factors—this subjectivity reflects the complexity of defining health and well-being. Therefore, the built environment must be adaptable to satisfy these diverse needs and improve overall well-being (Christoforou et al., 2024).

Although there are differences in the definitions of healthy office buildings, they all highlight the promotion of social, mental, and physical well-being. These buildings are made to be devoid of dangerous materials, have sustainable elements, and offer a holistic approach to health. Healthy office buildings strive to provide comfortable, secure, and supportive environments that boost the productivity and well-being of their occupants.

3.3 Foundational Elements of a Healthy Office Building

A basic healthy office is meant to improve its occupants' physical and mental well-being by enhancing key environmental factors. These offices strive to create healthy and productive environments by carefully managing indoor environmental (IEQ) components such as air quality, lighting, thermal comfort, acoustics, office layout, etc. There is growing acknowledgement that, in addition to preventing harm, workplaces should actively promote to employee well-being by addressing these variables (Kropman et al., 2022).

A healthy office often offers an environment that promotes both mental and physical wellness. In terms of minimum standards, most frameworks recommend that certain baseline conditions be satisfied, such as adequate thermal comfort, air purity, lighting, and so on. However, depending on

client preferences, different features might be implemented to improve employee satisfaction and productivity (Kropman et al., 2022). Globally, there is a growing awareness and demand for healthy workspaces, led by frameworks such as WELL and LEED, which provide criteria for designing buildings that actively promote well-being (Kropman et al., 2022).
A healthy office building includes various fundamental components necessary to support its occupants' productivity, well-being, and general health. This review combines findings from four research perspectives, including the "9 Foundations of a Healthy Building," to highlight the major aspects contributing to developing and maintaining healthy office environments.

1. **Air Quality and Ventilation:**
   Good indoor air quality (IAQ) is essential for occupant health and productivity. Proper ventilation aids in diluting and removing indoor pollutants, lowering symptoms of Sick Building Syndrome (SBS) and improving workplace performance. To guarantee clean air and stop the accumulation of dangerous materials, efficient filtering systems and routine air quality monitoring are required (Allen et al., 2017; Bluyssen et al., 2011; Heidari et al., 2016; Horr et al., 2017).
2. **Thermal Comfort:**
   Optimal thermal conditions are crucial for occupant satisfaction and productivity. This includes regulating temperature, humidity, and air velocity to avoid thermal stress and discomfort. According to several studies (Bluyssen et al., 2011; Horr et al., 2016), proper thermal management can enhance cognitive function and general well-being.
3. **Lighting:**
   Adequate illumination, especially natural daylight, substantially impacts occupant well-being. Good lighting design improves mood, eases eye strain, and maintains circadian rhythms, contributing to increased productivity and better mental and physical health. A healthy office environment must include enough natural light and lighting systems to meet biological needs (Allen et al., 2017). Noise levels and acoustics significantly influence the degree of comfort and productivity of occupants is significantly influenced by noise levels and acoustics. Excessive noise can cause stress, decreased concentration, and poor performance. According to several studies (Allen et al., 2017; Horr et al., 2016), suitable acoustic design and effective noise control methods are crucial for creating a conducive work environment.
4. **Moisture and mold control:**
   Moisture control in the workplace environment is critical to preventing mould growth and associated health problems. Controlling moisture sources and ensuring that spaces prone to dampness have enough ventilation are important strategies. As per (Allen et al., 2017; Bluyssen et al., 2011), promptly addressing moisture-related concerns can prevent health complications associated with mould growth and maintain a healthy indoor environment.
5. **Personal Control:** Providing occupants with some degree of control over their surroundings, including the ability to change the lighting, ventilation, and temperature, can improve their comfort and satisfaction. Personal control over the indoor environment can increase well-being and productivity by allowing personalization based on individual preferences (Bluyssen et al., 2011).
6. **Office Layout :**
   An office's physical layout influences work routines, interactions, and productivity. Office

layouts that balance privacy and interaction can improve occupant satisfaction and efficiency. Office layouts—such as open-plan, cellular, or hybrid—can meet different occupant preferences and organizational needs (Horr et al., 2016).

7. **Biophilia and Access to nature :**
   Stress levels can be lowered, and mental health can be enhanced by incorporating natural features and providing access to outdoor views. It is advantageous to have elements like windows overlooking natural scenery, green walls, and indoor plants. By fostering a connection to nature, biophilic design enhances occupant satisfaction and productivity (Heidari et al., 2016; Horr et al., 2016).
8. **Ergonomics:**
   The ergonomic design of workplace furniture and workstations is essential for increasing comfort and preventing musculoskeletal problems. Adjustable furniture, appropriate seating, and well-designed workstations improve physical health and productivity (Allen et al., 2017; Bluyssen et al., 2011).
9. **Dusts and Pests :**
   Managing dust and pests helps reduce allergens and chemical exposures. A few strategies that help prevent the impacts of dust and pests include frequent cleaning to reduce dust accumulation, developing integrated pest control programs, and avoiding pesticide use whenever possible (Bluyssen et al., 2011; Horr et al., 2017).
10. **Community and Social Well-being:**
    Community cohesion and social interactions should be encouraged in the design of buildings and neighbourhoods. A sense of community and pleasant social connections are promoted by features including communal spaces, recreational areas, and social facilities, which support mental and physical health and help improve the overall well-being of residents (Heidari et al., 2016).
11. **Safety and Security:** The well-being of building occupants depends critically on ensuring their safety and security. This includes providing secure entrance points, developing emergency plans, and maintaining a safe atmosphere to decrease stress and promote overall wellness. Safety was identified as a key factor in defining healthy office buildings, making it one of the essential components of this study (Heidari et al., 2016).

These foundational elements highlight how important it is to holistically address the design and upkeep of healthy office buildings. By addressing these important elements, organizations can build environments that promote their employees' physical and emotional well-being, resulting in enhanced productivity and satisfaction. These elements include factors involved in both the design and maintenance phases of a building. However, this project's scope focuses on design considerations and elements in the indoor environment rather than external variables. Therefore, the list is reduced to the following essential elements associated with design considerations: Air Quality and Ventilation, Thermal Comfort, Lighting, Acoustics and Noise Control, Moisture and Mold Control, Personal Control, Office Layout, Biophilia and Access to Nature, Safety and Security, and Community and Social Well-being.

These elements will be assessed to determine which are most appropriate for the context and which should be prioritized. This evaluation will be evaluated further through different qualitative methods to get practical insights, such as stakeholder interviews, and prioritized using surveys.

3.4 Identifying Stakeholders in Healthy Office Building Projects

Designing and implementing healthy office environments requires the involvement of various stakeholders, who have unique perspectives and functions that can either drive or hinder the development of a truly healthy workspace. Each stakeholder is vested in the outcome, contributing their expertise, goals, and expectations. According to (Appel-Meulenbroek, Arentze, Kemperman, Buskermolen, & Van Den Putten, 2021), the success of a healthy office building project is determined by how well diverse stakeholders' needs are aligned, as this alignment directly impacts occupant health and well-being outcomes. Stakeholder involvement is critical in determining project goals and influencing design decisions throughout the project's lifecycle.

Building owners and developers choose the project's financial and strategic direction, while architects include health and well-being requirements into the physical design (Kwon, Remøy, & Van Den Dobbelsteen, 2019). Consultants and regulatory agencies guarantee that the project complies with applicable standards and laws, such as WELL and BREEAM-NL. Meanwhile, as end users, occupiers provide valuable feedback on how effectively the environment supports their health and productivity (Appel-Meulenbroek et al., 2021). Each of these stakeholders has a unique function at different stages of the project, influencing not just the design but also the long-term success of the office environment.

Including these stakeholders is critical to creating a balanced outcome that meets organizational goals and occupant well-being requirements (Kwon et al., 2019). However, their different priorities and perspectives can occasionally lead to conflicts that hinder the overall process. Understanding their responsibilities, contributions, and possible challenges is essential to implementing health-focused office environments effectively. Below is a breakdown of the key stakeholders and their roles.

1. **Building Owners and Developers:** Building Owners and Developers: As the primary decision-makers responsible for financing and guiding the construction or renovation of office buildings, their commitment significantly impacts the direction and achievement of health and well-being goals (Appel-Meulenbroek et al., 2021).
2. **Architects and Designers:** These professionals are responsible for incorporating health and well-being criteria into building designs, ensuring standards are met while balancing aesthetics, functionality, and occupant comfort, thereby contributing to the success of these projects (Kwon et al., 2019).
3. **Facility Managers:** They oversee the day-to-day operations and maintenance of the building, ensuring ongoing compliance with health and well-being standards, which is vital in maintaining the quality of the indoor environment (Huber, Koch, & Busko, 2014).
4. **Consultants (WELL Accredited Professionals and BREEAM Assessors):** Consultants provide specialized knowledge and guidance to ensure the project meets all necessary criteria and successfully achieves health and well-being goals (Kwon et al., 2019).
5. **Occupants/Employees:** As end-users, their health and productivity are paramount, and their feedback is crucial in ensuring the building meets their needs.

6. **Regulatory Authorities:** These bodies enforce building codes and standards, ensuring legal compliance and the project's success (Appel-Meulenbroek et al., 2021).
7. **Corporate Real Estate Managers:** They manage the organization's property portfolio, aligning real estate strategies with health and well-being goals (Appel-Meulenbroek et al., 2021).

3.5 Current Practices and Frameworks in the AEC Sector

The Dutch construction and real estate industries increasingly focus on creating healthier and more sustainable office environments, recognising the built environment's impact on employee health and well-being. Certification systems such as BREEAM-NL and the WELL Building Standard have emerged as essential tools for directing office building design, construction, and operation prioritising occupant health and well-being.

BREEAM-NLis one of the most well-established sustainability certification systems in the Netherlands, primarily focusing on decreasing buildings' environmental effects throughout their lifecycle. BREEAM-NL considers health and well-being, especially regarding indoor environmental issues such as air quality, thermal comfort, and lighting (of Technology & Dekkers, 2018).
WELLBuilding Standard at the same time, effectively prioritises human health and well-being. WELL is organised around ten basic ideas directly impacting occupant health: air, water, light, movement, nourishment, thermal comfort, sound, materials, mind, and community. This standard highlights indoor environmental factors that impact health, with specific criteria to improve building occupant well-being (Ildiri et al., 2022; Obrecht, Kunič, Jordan, & Dovjak, 2019; of Technology & Dekkers, 2018). However, some research sources, including those from (Ferreira, 2024; LIMITED, 2024), have highlighted a few disadvantages of pursuing WELL certification, citing high costs, a complex documentation process and ongoing maintenance requirements that can be resource-intensive and difficult for organisations to meet.

Studies evaluating the contribution of BREEAM-NL and WELL certifications to the promotion of health and well-being show that while both have a good effect on indoor environmental quality, WELL has a more concentrated and noticeable effect on occupant health. Compared to BREEAM-NL, WELL has more stringent air quality, light, and mental health requirements, all of which are also subject to more strict monitoring and assessment. Furthermore, BREEAM-NL focuses less on post-occupancy evaluations, which WELL emphasizes heavily as a means of continuously improving building conditions by incorporating feedback from occupants (Ildiri et al., 2022; of Technology & Dekkers, 2018).

Each certification considers various critical variables contributing to health and well-being, as shown in Table 6 in the (Berquand et al., 2022). This Research demonstrates how WELL broadens its scope to include more complex concepts like community involvement, mental health, and nutrition, all essential for holistic well-being. At the same time, BREEAM-NL focuses on more fundamental aspects like visual comfort, IAQ, and thermal comfort. This table shows that, although BREEAM-NL addresses fundamental factors such as visual comfort, IAQ, and thermal comfort,

WELL broadens its scope to include more advanced concepts such as community participation, mental health, and nutrition, all of which are critical for overall well-being. 3.1 shows the different elements each of these guidelines addresses to achieve health and well-being goals.

BREEAM-NL and WELL play important roles in the Dutch industry's pursuit of healthier, more sustainable office buildings. BREEAM-NL provides a framework for integrating health into broader sustainability goals, making it an adaptable tool for companies seeking to balance environmental and health concerns. Conversely, WELL takes a more targeted approach to health and well-being, making it ideal for firms that value these factors (Berquand et al., 2022). However, organizations must carefully consider WELL certification's downsides, such as its high cost, complex certification procedure, and continuous maintenance requirements (Ferreira, 2024; LIMITED, 2024).

Table 3.1: Foundational elements as mentioned in BREEAM-NL (Health) vs WELL V2

BREEAM-NL (Health)	**WELL V2**
Healthy Indoor Air	Air
Thermal Comfort	Thermal Comfort
Acoustics	Sound
Visual Comfort	Light
Ventilation	Water
Accessibility	Movement
Outdoor Spaces	Nourishment
Biophilic Design	Materials
Safety	Mind
Smart Home	Community
	Innovation

3.6 Gaps identified from the literature insights:

The literature provides an overview of what makes up a healthy office building, addressing physical, psychological, and social factors that contribute to total well-being. Air quality, thermal comfort, lighting, acoustics, spatial comfort, access to nature, personal control, water, safety and accessibility are all considered essential components for enhancing health and productivity in an office building (Bluyssen et al., 2011; Horr et al., 2016). Given these findings, some areas require to be addressed to fully optimize the integration of well-being into office design and construction, particularly in the Dutch context, such as:

Different Definitions and Subjectivity in Healthy Office Buildings:
The literature emphasizes the availability of many definitions of a healthy office building, demonstrating the subjectivity of the idea (Christoforou et al., 2024). Because the idea is perceived as subjec-

tive, the solution to designing a healthy office building in the Netherlands requires an understanding of context-specific needs and processes. Obtaining various practical viewpoints from stakeholders is critical for answering this, as their input will assist in designing and prioritising well-being goals based on the unique demands of each project.

Context-Specific Requirements and Application of Current Guidelines:
Local legislation, cultural expectations, and environmental factors must all be considered when implementing health and well-being measures. While frameworks such as WELL, BREEAM-NL, and Bouwbesluit offer helpful guidance, it is unclear how these frameworks are used in reality throughout different stages of an AEC project in the Netherlands. Identifying how these standards can be tailored to local circumstances and comprehending their implementation throughout the design and construction phases is critical to ensuring they effectively support occupant well-being.

Challenges with Regulatory Misalignment and Administrative Burdens:
The literature discusses difficulties such as regulatory misalignment and administrative burdens (Ferreira, 2024) but does not provide precise insights into how these challenges appear in practice. The importance of these issues must be clarified—whether they are major barriers that require immediate attention or minor barriers that can be overcome during the project's lifecycle. Understanding who is accountable for overcoming these problems and when and how they should be addressed is crucial for successfully implementing well-being policies in Dutch office buildings.

The literature provides a solid foundation for understanding the important components of a healthy office structure, focusing on air quality, illumination, thermal comfort, and access to nature. The literature also emphasizes the ambiguity in identifying a healthy office building, expressing subjectivity. Because the idea is subjective, determining how to design a healthy office building in the Netherlands involves understanding context-specific requirements and processes. Gaining practical perspectives from stakeholders is critical for refining well-being goals and determining the applicability of present strategies. As a result, the literature's knowledge needs to be refined further by gathering stakeholder insights to properly design healthy office buildings in the Dutch setting.

4

Empirical Insights and Analysis-1: Defining Healthy Office Building and Components

This section highlights the findings from stakeholder interviews and surveys, which are critical for identifying the components of a healthy office building. Recognizing the subjectivity of the concept, as indicated in the literature review, this study used a practical approach, using semi-structured interviews and surveys to consider diverse perspectives. These methods provided professionals' perspectives on the design and construction practices of a healthy office building. The respondents, which include architects, contractors, MEP engineers, sustainability and well-being consultants, facility managers, lighting designers, and acoustic designers who are involved in the current projects or completed office building projects with established health and well-being goals, were chosen because they have firsthand knowledge of the present processes. Each participant was given a unique code to ensure confidentiality, as shown in the table below. The following analysis outlines practical insights with theoretical foundations to provide an understanding of a consolidated definition of a healthy office building and what elements it includes. This chapter will help reinforce the literature findings and answer the **SQ1**.

Table 4.1: Stakeholders and Assigned Codes

Stakeholder Role	**Code Assigned**
Architect 1	AR1
Architect 2	AR2
Sustainability and Well-being Consultant 1	SWBC1
Sustainability and Well-being Consultant 2	SWBC2
Sustainability and Well-being Consultant 3	SWBC3
Corporate Real Estate Well-being Lead 1	CRE1
Contractor 1	C1
Corporate Real Estate Well-being Lead 2	CRE2
Facility Manager 1	FM1
MEP Expert 1	MEP1
Lighting Designer 1	LD1
Lighting Designer 2	LD2
Acoustic Designer 1	AD1
Sustainability Consultant 1	SC1

4.1 Defining a Healthy Office Building

While frequently explored in literature, the concept of a healthy office building is still subjective and evolving, particularly in the Dutch AEC (Architecture, Engineering, and Construction) industry. Recognizing the significance of this idea, the first part of interviews for this study sought to uncover how various stakeholders—those directly involved in the design, construction, and usage of office spaces—perceive and describe a healthy office building.

The literature research emphasized the need to understand stakeholder perspectives on healthy office buildings (3.4), as these individuals significantly impact the design and construction processes. The interviews found that stakeholders recognize the importance of health and well-being in office design, but their understanding and definitions of a healthy office building differ greatly. This interpretation emphasizes the subjectivity of the concept C. In addition to the interviews, a survey was carried out with one of the questions assessing stakeholders' levels of awareness and understanding. The survey asks, "How do you know what you know about healthy buildings?" According to the results, 60% of stakeholders learned about healthy building through consultations with professionals, while 25% attributed their understanding to the increased need and awareness of healthy office settings. Another 25% stated that their knowledge was acquired through independent study. These

findings indicate various levels of awareness and increasing recognition of the significance of healthy working environments 4.1.

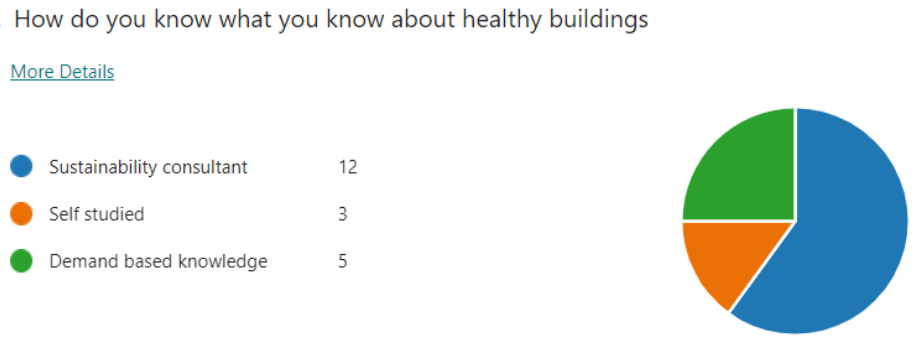


Figure 4.1: Survey insights: Healthy building source of awareness

One of the interviewees stated that he initially saw the concept of a healthy office building as a primitive problem until he explored deeper into the subject and realized its importance to the occupant's well-being, the impact it has on productivity, and how that yields long-term benefits for a company and also increases the market value of the real estate asset (C1). This understanding led his company to seek the highest WELL certification for his office.

> **C1**: *"When I first came across developing healthy buildings, I thought it was a first world problem"*

Another insight came from a professional with over 20 years of industry experience who gave a historical perspective, emphasizing that the WELL certification was originally designed to bring market value to real estate projects rather than focusing on health and well-being (SC1). This insight illustrates a shift in objectives over time, focusing on building environments that value employee health, well-being, and satisfaction.

> **SC1**: *"It might be really interesting for you to know that the WELL certification was developed primarily to add market value to real estate projects and once implemented they got surprising branching results as well"*

In addition, there was a question in the stakeholder survey: "Do you interact with the topic of healthy workplaces often today?". 90% of the stakeholders that participated in the survey said yes, demonstrating the growing awareness and desire as seen in the figure 4.2.

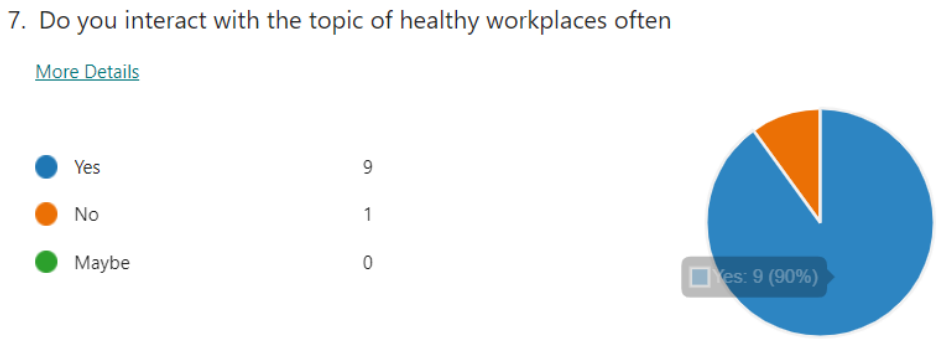


Figure 4.2: Survey insights: Healthy building interaction frequency

The literature study helped understand the fundamental elements and basic definition of a healthy office building as a workplace that facilitates the health and well-being of occupants while ensuring safety and comfort and highlighting the need to understand a stakeholder's perspective. Based on the various definitions offered by stakeholders that can be seen in the Appendix (C)along with the literature perspective, it is observed that they all define it differently, but the fundamentals of it remain the same. Hence, considering all the mentioned keywords and aspects, a consolidated definition can be developed to generate a common vision for a healthy office building:

"A Healthy Office Building is a dynamic workplace designed to promote the holistic well-being of its occupants by prioritizing health, happiness, safety, and productivity. Such a workspace seamlessly combines foundational elements that impact occupant health and well-being to ensure physical and mental comfort. It is a space that:

- Promotes Health: Provides clean air and water free from contaminants.
- Increases Comfort: Offers optimal thermal, auditory, and visual conditions.
- Fosters contact: Promotes social contact and a sense of community.
- Supports Flexibility: Provides personal control over ambient conditions and the option to take pauses.
- Ensures Safety: Provides physical and psychological safety and security.

This consolidated definition of a healthy office building can serve as a starting point for establishing well-being objectives in office design projects. While not adding any new components, this definition unites the fundamentals identified in the literature—such as air quality, thermal comfort, and lighting—with practical insights from stakeholders. The literature addresses these essentials in various ways; this study gathers them from research and practice. The resulting definition helps align stakeholder perspectives and provides a flexible foundation for defining well-being goals for specific projects, understanding that one size does not fit all in this context. By offering this consolidated starting point, the research helps to integrate important fundamentals in theory and practice, allowing for more effective incorporation of well-being strategies adapted to each project's specific needs.This definition serves as a starting point, but it is adjustable, acknowledging that opinions on what defines a healthy office building will continue to grow.

4.1.1. Conceptual Subjectivity.

The interviews emphasized the subjectivity of the idea of a healthy office building. Although common components were recognized, such as the importance of health, well-being, and comfort, definitions differed among stakeholders. Architects, building owners, facility managers, and tenants had different perspectives on what makes a healthy work environment C. An occupant survey asked what makes your office atmosphere great, and the image below depicts the various responses and the vast range of ideal work environment perceptions.

This diversity of perspectives emphasizes the importance of acknowledging and treating subjectivity in the idea of healthy office buildings. It also emphasizes the significance of developing a clear and consistent vision for well-being objectives early in the project. Recognizing all stakeholders' diverse priorities and goals allows project teams to guarantee that the design and construction processes fit with the collective well-being objectives, resulting in office spaces suited to all users' requirements and expectations. This approach improves the relevance and effectiveness of the well-being methods deployed. It develops a collaborative environment where all stakeholders work together to create places supporting health and productivity.

> **SC2**: *"It is important to align all the stakeholder goals early on because occupant perceptual subjectivity is an inherent challenge in designing healthy workplace settings, as users' demands and preferences vary."*

Addressing these subjective requirements early in the project, especially during the goal-setting and design stages, can help avoid potential conflicts and create a more inclusive and adaptive workspace. By aligning stakeholder perspectives early on, project teams can develop a unified vision for well-being goals that considers all stakeholders' varying expectations.

> **AR2**: *"it is unlikely that every individual preference can be fully met, incorporating flexible design strategies—such as personal control over environmental conditions, adaptable office layouts, or modular workspaces—enables a level of customisation that addresses many of these subjective needs."*

These solutions enable adaptation and ensure that occupant well-being is prioritised throughout the design process. In this way, the subjective needs of many users can be balanced through smart, adaptable design techniques, ultimately improving the general health and productivity of the workplace environment.

The following table 4.2 represents themes and codes that were useful in determining how stakeholders perceive and interact with the concept of healthy office buildings. The table shows the degree of awareness. The table highlights essential insights from interviews (stakeholder perspectives), which can assist in developing well-being goals for healthy office-building projects. Themes such as "Varied Knowledge Sources" and "Evolving Perceptions" demonstrate how stakeholders understand a healthy environment, emphasizing the importance of early collaboration and adaptability. The thematic analysis emphasizes the necessity of early collaboration and collaborative goal-setting to implement healthy office-building initiatives effectively. This analysis guarantees that well-being

goals consider both theoretical and practical issues, allowing for the design of more personalized and successful workplace environments.

Table 4.2: Themes of research insights on healthy building definition

Theme	Codes	Description
Varied Knowledge Sources	- Consultant-driven knowledge - Demand-driven awareness - Self-study	Reflects the diversity in how stakeholders acquire knowledge about healthy office buildings through consultants, market demand, or independent research.
Evolving Perceptions	- Initial skepticism - Realization of impact - Advocacy for well-being	Highlights the shift from skepticism to recognizing the importance of health and well-being, leading some stakeholders to become advocates for the concept.
Holistic Well-being	- Health and air quality - Comfort and interaction - Safety and flexibility	Encompasses various elements identified as essential for a healthy office building, such as air quality, comfort, and the ability to interact and feel safe.
Diverse Stakeholder Perspectives	- Architectural perspectives - Owner and occupant perspectives - Varying visions	Captures the varied definitions and priorities of different stakeholders, showing the subjectivity inherent in the concept of a healthy office building.
Collective Goal Setting	- Early-stage collaboration - Well-being goal setting - Shared understanding	Reflects the importance of establishing a shared vision and well-being goals among stakeholders early in the project to ensure alignment and coherence.

4.2 Elements that constitute a healthy office

The literature has extensively documented the foundational elements of a healthy office building, identifying critical components such as air quality and ventilation, thermal comfort, lighting, acoustics and noise control, moisture and mould control, personal control, office layout, biophilia and access to nature, safety and security, and community and social well-being. These aspects support a healthy work environment, boosting occupant well-being and productivity. However, the initial list based on literature has been revised and confirmed using practical observations from stakeholders in the Dutch AEC industry. The table shows a revised list of the foundational elements of a healthy office building. During the stakeholder interviews, accessibility was highlighted as an important element.

> **FM1**: *"An accessible office space adds tremendous value by meeting the basic needs of all types of occupants, ensuring inclusivity and improving the overall office atmosphere."*

[SWBC1] also additionally vouched by highlighting accessibility as an important element.

Another important factor highlighted is the choice of building materials, particularly those that avoid dangerous compounds.The significance of this aspect in maintaining a healthy indoor environment, stating that the materials used directly impact the well-being of the building's occupants, was emphasized. This understanding emphasizes the importance of using non-toxic, sustainable materials in office design.

> **C1**: *"Use of safe building materials has a major impact on the occupant's health and well-being, all things considered, if the material specifications do not meet healthy standards it might not help in having the place we aimed for."*

One of the interviewees presented examples of how implementing restorative areas in their working setting significantly increased occupant happiness and productivity in their office building (CRE1).

> **CRE1**: *"We experimented incorporating break rooms in one of our offices and did not in our office right next to it and we saw the positive impact that a break room can have on occupants and their work flow during work hours."*

These areas allow employees to unwind and revitalize during the workday, making them an important part of a healthy office environment [CRE1, AR2, FM1]. Another insight underlined the necessity and accessibility of good quality drinking water in boosting worker health and efficiency. The strategic placement of accessible water sources improved employees' physical well-being and workflow [FM1].

> **FM1**: *"It is very important to have accessible drinking water points because it can either hinder or boost the workflow of an employee in an office floor during work time."*

In the next stage of the research, a comparison of these selected factors to those considered by current guidelines such as WELL, BREEAM-NL, and the current building Code will be conducted. The new list, which now includes Accessibility, Building Materials, Restorative Spaces, and water points, reflects the changing priorities of the Dutch AEC industry and office occupiers' practical requirements. After combining the three additional aspects identified through stakeholder interviews and occupant surveys, the foundational elements of a healthy office building can be systematically classified into the following list:

Table 4.3: Elements Constituting a Healthy Office Building

Element	**Source (Literature/Interviews)**	**Essential**	**Essential Enhancement**
Indoor Air Quality	Literature	Yes	
Thermal Comfort	Literature	Yes	
Acoustic Comfort	Literature	Yes	
Visual Comfort - Lighting Design	Literature	Yes	
Visual Comfort - Views from Desk	Literature/Interviews	Yes	
Visual Comfort - Daylighting	Literature/Interviews	Yes	
Spatial Comfort - Restorative Spaces	Interviews	Yes	Yes
Spatial Comfort - Facilities Provision	Interviews	Yes	Yes
Spatial Comfort - Active Design Measures	Interviews	Yes	Yes
Biophilic Design	Literature	Yes	Yes
Personal Control	Literature/Interviews	Yes	Yes
Accessibility	Interviews	Yes	
Water - Drinking Water	Interviews	Yes	
Water - Moisture Management	Literature/Interviews	Yes	
Safety - Avoid Hazardous Materials	Interviews/Literature	Yes	
Safety - Avoid Hazardous Design	Literature/Interviews	Yes	

The chapter's findings show the diverse and subjective ways stakeholders in the Dutch AEC industry understand the concept of a healthy office building. The list of the foundational elements derived from literature and interviews underlines the relevance of inclusive design and occupant well-being, which enriches the theoretical frameworks. These findings contribute to a more nuanced understanding of how various stakeholders, from architects to occupants, shape a project's well-being goals. This study underlines the importance of early collaboration and flexible design solutions in dealing with the inherent subjectivity in occupant preferences.

The following chapter will examine current approaches to developing healthy office settings, including WELL and BREEAM standards. It will look at how these frameworks are implemented throughout the project's stages and the challenges that stakeholders encounter, such as aligning design strategies with health and well-being goals, managing constraints, and assuring compliance with health-related outcomes. This study will give a practical context for the theoretical and empirical insights gained, showing how healthy office buildings are designed in real-world settings.

5

Empirical Insights and Analysis-2: Current Practices, Project Processes and Challenges

This chapter focuses on the industry's current practices for designing healthy office buildings, emphasising the most commonly utilised standards and how industry experts apply them. It includes an overview of the various project phases and the specific considerations for incorporating Key Performance Indicators (KPIs) linked with each project's well-being objectives. The chapter also discusses the challenges that industry experts face during this process, such as combining regulatory obligations with well-being targets, administrative constraints, and the complexities of applying global frameworks like WELL to local contexts. The insights offered in this chapter are based on interviews with stakeholders and industry professionals, providing a realistic grasp of the solutions and challenges involved in developing healthier workplace environments. This chapter additionally helps in answering the **SQ2 and SQ3**

Various organisations in the Dutch AEC industry are adapting different frameworks and certifications to create healthier office spaces. The WELL Building Standard and BREEAM-NL are the two frameworks that are most frequently cited; they both provide distinctive strategies for promoting health and well-being in office environments. Adherence to the Dutch Building Code (BBL) also sets the minimum standards for building safety and environmental performance. However, it is frequently mentioned by many stakeholders interviewed as the bare minimum for ensuring comprehensive occupant well-being.

> **MEP1**: *"Bouwbesluit/BBL does have health considerations but is considered as the bare minimum. It is not enough to ensure occupant well-being."*

(Similar or the same opinions were expressed by other interviewees as well such as LD1, LD2, SWBC2, AR2.)

5.1 Guidelines and Standards

5.1.1. Use of WELL Certification

Companies commonly use the WELL Building Standard as a framework to improve health and well-being in office settings. Its adoption, though, differs greatly amongst organisations. Certain companies use WELL selectively, especially for larger projects or new buildings, like those employing more than 250 people. In these situations, WELL is followed merely as a checklist or guideline rather than as a strict requirement for complete certification across all properties. Companies can incorporate crucial well-being elements with this approach without undergoing the complex and expensive certification process (CRE1).

> **CRE1**: *"Using WELL as a checklist helped us design healthier office buildings so we can refine the checklist according to our requirements while addressing aspects of WELL and make our buildings "WELL READY" and not "WELL certified" to save on all the administrative burden the process puts us through."*

An interview insight suggested that regional practices or requirements in some areas differ from those specified in the WELL guidelines.

> **LD1**: *"The WELL guidelines do have requirements that do not hold good for the Dutch context."*

The same was also vouched by multiple other interviewees(AR2, LD2, SWBC2) Consequently, rather than pursuing complete certification, businesses may implement particular WELL features that complement their operational objectives (SWBC2). This selective application of WELL features allows for flexibility in meeting the unique requirements of different office environments.

> **SWBC2**: *"Companies at times just pick the desired requirements from the WELL guideline that suits their project vision."*

Furthermore, some companies are taking a more integrated approach by developing internal well-being guidelines and governance frameworks. These internal policies are influenced by broader HR initiatives that aim to establish outstanding work environments (CRE1,FM1).

> **FM1**: *"We aim to develop our well-being guidelines, many companies have already done that for all the topics they consider for well-being."*

. This indicates a growing trend in which well-being initiatives align with larger sustainability goals while ensuring that office environments support health and ecological responsibility.

5.1.2. Integration of BREEAM and Other Guidelines

Another well-known certification with a strong emphasis on sustainability is BREEAM-NL. It is not as complete as WELL regarding well-being, even though it does cover some factors of comfort and physical health. While BREEAM and WELL share several similarities, it was noted out that BREEAM prioritises environmental sustainability over occupant well-being (MEP1, AR1, SWBC2).

> **MEP1**: *"Well, BREEAM-NL is widely used, it has requirements for health as well but it focuses more on sustainability goals, and when anything related to health and well-being goals come into the picture we suggest to go for WELL certification."*

.

The Dutch Building Code (BBL), which establishes minimal standards for environmental performance and safety, is considered the starting point for building regulations in the country. Stakeholder interviews have shown that the provisions of BBL are often viewed as bare minimum for guaranteeing the creation of healthy working environments. The BBL is often regarded as providing the basic minimal criteria, which may not sufficiently address the more substantial aspects of occupant health and well-being.

Tailored Well-being Strategies and Technological Integration

Companies are increasingly turning to specialised well-being strategies that consider their employees' social, emotional, and mental health aspects. Rather than closely adhering to predetermined certification requirements, these strategies are frequently tailored based on the unique needs and objectives of the organisation.

> **CRE1**: *"We, not just us, in fact, a lot of other players in the industry too, are seeking to create our own well-being strategies to address the physical, social and mental well-being of our employees alongside the certifications based on our own requirements."*

> **C1**: *"If you observe the latest trends in the industry, use of smart building technologies are becoming more common, such as sensors and data-driven management systems, help monitor environmental factors like air quality and acoustics in real-time, enabling continuous improvements to office environments."*

Feedback and Continuous Improvement

> **CRE2**: *"Another emerging practice is the development of well-being dashboards that provide real-time data on how well the office space performs."*

Tools like these help monitor the variables related to environmental quality and satisfaction rates to ensure that workspaces adequately promote their employees' health. This data-driven approach allows companies to make informed decisions and adapt well-being strategies over time based on actual performance and user input.

The decision-making process for large-scale projects involves consultation with a wide range of stakeholders, such as contractors, architects, and officials from the municipality. These stakeholders must get involved early on to ensure the project's overall vision and the well-being goals are compatible.One of the interviewees also mentioned the following:

> **SWBC2**: *"Usually what works well or what we usually practice might be different than another organisation we work with, and design projects like these involve many stakeholders, early understanding of stakeholder goals becomes very important."*

CRE2,CRE1, and AR2 also shared similar opinions on stakeholder involvement in the project.

5.2 Comparing foundational elements and their KPI's selection across different guidelines

To better understand the effectiveness of these frameworks, an analysis of the selected foundational elements from the literature review, interview insights and the elements considered by different existing guidelines is necessary. This analysis will help distinguish which foundational elements are best suited for the context of Dutch office buildings and can help understand if the current guidelines include them. The selection of foundational elements through literature and interview insights, as shown in (table4.3)helped form a list of elements to consider while designing a healthy office building, and h=the following table gives an overview of the different elements the guidelines in use in the industry consider.

Table 5.1: Comparison of Foundational Elements Across Standards

Foundational Element	**BBL**	**WELL**	**BREEAM-NL**
Indoor Air Quality	✓	✓	✓
Thermal Comfort	✓ (primitive)	✓	✓
Acoustic Comfort	✓ (only outdoor)	✓	✓
Visual Comfort	✗	✓	✓
Lighting Design	✗	✓	✓ (primitive)
Views from Desk	✗	✗	✗
Daylighting	Primitive	✓	✓
Spatial Comfort	✗	✓ (not all aspects)	✗
Restorative Spaces	✗	✗	✗
Biophilic Design	✗	✓ (not all aspects)	✓
Personal Control	Primitive	✓	✓
Accessibility	Primitive	✓ (not all aspects)	✓
Water	Primitive	✓	✓
Drinking Water	✗	✓	✓
Moisture	Primitive	✓	✓
Safety	✓ (primitive)	✗	✓
Avoid Hazardous Materials	Primitive	✓	✓
Avoid Hazardous Design	✗	✓ (not all aspects)	✓

The key performance indicators for each foundational element were determined through a content analysis that included a comparison of the Dutch Building Code (BBL) and the WELL Building Standard. This analysis sought to find the most relevant KPIs for the Dutch context, ensuring that the framework was consistent with local regulations and aligned with the practices for improving health and well-being. Interviews with experts such as MEP engineers, lighting designers, acoustic consultants and well-being consultants helped to validate and refine the selected KPIs. These experts shared their views regarding which indicators are most important for achieving optimal health and well-being outcomes in office settings. This multi-step process, which includes a literature review, comparative analysis, and expert validation, ensures that the selected core elements and KPIs are strong, context-specific, and aligned to create healthier office environments in the Netherlands. The following table overviews the selected foundational elements and their KPIs.

Table 5.2: Coverage of Key Performance Indicators (KPIs) in BBL, WELL, and BREEAM-NL Standards - Part 1

Element	KPI	BBL	WELL	BREEAM-NL
Indoor Air Quality	CO_2 Range	✓	✓	x
	CO Range	✓	✓	x
	Formaldehyde Measure	✓	✓	✓
	TVOC Measure	x	✓	✓
	Particulate Matter (PM2.5 and PM10)	x	✓	✓
	Air Velocity	✓	✓	x
	Ventilation Rate	✓	✓	✓
	Air Filters	x	✓	✓
	Air Permeability	x	x	✓
Thermal Comfort	Temperature	x	✓	✓
	Humidity	x	✓	x
	PMV Range	x	✓	x
	Air Velocity	✓	✓	x
Acoustic Comfort	Maximum Noise Levels	✓	✓	✓
	Reverberation Time	x	✓	✓
	Sound Insulation Between Rooms	✓	✓	✓
	Speech Privacy	x	✓	x
	Sound Absorbent Features	x	✓	x
	Acoustic Zoning	x	✓	x

Table 5.3: Coverage of Key Performance Indicators (KPIs) in BBL, WELL, and BREEAM-NL Standards - Part 2

Element	KPI	BBL	WELL	BREEAM-NL
Visual Comfort	Lighting Level	✓	✓	✓
	Circadian Lighting	x	✓	x
	Electric Glare	x	✓	✓
	Solar Glare	x	✓	✓
	Uniformity	x	✓	x
	Color Temperature	x	✓	x
	Flicker	x	✓	x
	Daylight	✓	✓	✓
	Views from Desk	x	x	x
Water Quality	Free Draining Spaces	x	✓	x
	Non-Porous Materials	x	✓	x
	Moisture Management	✓	✓	✓
	Accessibility to Drinking Water	x	✓	x
	Quality of Drinking Water	x	✓	✓
Safety	VOC Thresholds	x	✓	✓
	Compliance Testing for Materials	x	✓	✓
	Mercury Thresholds in Equipment	x	✓	✓
	Lead Thresholds in Paints and Finishes	x	✓	✓
	Space Planning and Accessibility	x	x	✓
	Preventing Flooring and Trip Hazards	x	x	✓
	Security Measures	x	x	✓
Biophilic Design	Visual Connection to Nature	x	✓	✓
	Auditory Elements (Biophilic Soundscapes)	x	✓	x
	Multisensory Approach	x	x	x
	Natural Analogues	x	✓	✓
	Nature of the Space	x	x	✓
Spatial Quality	Active Office Design	x	✓	x
	Breakout Spaces	x	✓	x
	Spaces Promoting Collaboration	x	x	x

Table 5.4: Coverage of Key Performance Indicators (KPIs) in BBL, WELL, and BREEAM-NL Standards - Part 3

Element	KPI	BBL	WELL	BREEAM-NL
Accessibility	Circulation	✓	✓	✓
	Key Access Points	✓	x	✓
	Access to Facilities	x	x	✓
	Accessible Signage	✓	x	✓
	Equipment to Facilitate PwDs	x	x	✓
Personal Control	Zonal or Individual Thermal Control	x	✓	✓
	Dimming and Zonal Control of Lights	x	✓	✓
	Ventilation Control	✓	✓	✓
	Acoustic Masking	x	✓	x
	Privacy Controls	x	x	✓

5.3 Applicability of Current Frameworks to the Dutch Context

In this section, we investigate the applicability of current frameworks to the Dutch context using content analysis and expert interviews. The inquiry includes a comparison between the Dutch Building Code (BBL) and the WELL Building Standard, which is primarily utilized to promote healthy working settings. This comparative analysis is critical in determining the ideal levels for various Key Performance Indicators for each foundational factors pertinent to the Dutch context. A consolidation of all selected KPI's and their optimal levels is mentioned in the D.

The BBL is considered to ensure that the specified KPIs are compliant with local building codes. In the previous subsections in this chapter, we reviewed the fundamental concepts addressed by different guidelines and the aspects covered in BBL. Although these frameworks address many key aspects, it is important to critically analyze the indicators that assure the efficient functioning of these elements, particularly their applicability in the Dutch environment.

The content analysis began with a list of key performance indicators (KPIs) drawn from multiple frameworks. This list was refined through expert interviews to focus on the most important indicators influencing occupant health and well-being. Expert insights(lighting expert, acoustics expert, MEP expert, Sustainability and well-being experts, architects) were critical in determining the factors that drive each foundational element's optimal performance, which served as the foundation for picking the most important KPIs.

The next step was to evaluate the levels given by each framework for these KPIs. Even if a framework satisfies most of the necessary KPIs, the proposed levels or considerations may not correspond to the Dutch context, hindering the development of a healthy workplace environment. As a result, the purpose was to create a list of key performance indicators (KPIs) and their accompanying levels and requirements, along with the considerations for each design stage specifically for Dutch office buildings D. This final list, drawn from multiple recommendations and expert input, represents the

standards for building healthy working environments in the Netherlands.

Air Quality and Thermal Comfort

According to expert interviews, the optimal levels for Key Performance Indicators (KPIs) relating to air quality and thermal comfort in the Dutch setting are determined by standards, particularly the "Gezonde Kantooren" norm. The important KPIs for air quality are CO_2 range, CO levels, formaldehyde, Total Volatile Organic Compound (TVOC) readings, Particulate Matter (PM2.5), and air velocity. The "Gezonde Kantooren" guideline provides particular levels for various indicators considered appropriate for Dutch office buildings, thereby establishing a vision for preserving good indoor air quality. The consolidated optimal air quality and thermal comfort levels for designing healthy office buildings in the Netherlands can be seen in D.

> **MEP1**: *"For healthy air quality levels and thermal comfort levels although WELL certification has proven results, we don't completely follow it we use it in combination with the guideline "Gezonde Kantooren" which we saw holds good for practice in the Netherlands and was also developed in the Netherlands."*

In terms of thermal comfort, the findings show that, while the KPI ranges mentioned in WELL broadly align with the standards in "Gezonde Kantooren," there are differences in temperature thresholds for summer and winter, which provide flexible ranges for occupants adapting to current weather conditions and are also critical for achieving occupant comfort.

> **MEP1**: *"Air velocity is another important KPI when we address the features of air quality and thermal comfort."*

However, it was noticed that air velocity, a significant element influencing air quality and thermal comfort, is not addressed in the WELL framework despite being critical to achieving healthy indoor air quality and optimal thermal comfort. Furthermore, while WELL recommends using MERV filters for air filtration, they are rarely used in the Netherlands, emphasizing the necessity for other filtering methods. However, the Predicted Mean Vote (PMV) range, another important indication of thermal comfort specified in WELL, is considered adequate for Dutch office settings.

> **MEP1**: *"However, the PMV range given in WELL aligns with our PMV range targets as well."*

Visual Comfort

In studying visual comfort, particularly concerning lighting design and views from office buildings, interviews with lighting designers revealed some critical findings that illustrate that the levels mentioned in WELL guideline is not always optimal and must be used in combination with another suggested norm of NEN12464. The consolidated optimal visual comfort levels for designing healthy office buildings in the Netherlands can be seen in D.

> **LD1**: *"WELL does mention important KPI's, but for requirements in offices in the Netherlands, they require slightly varying levels for a few KPIs so we use the NEN12464 which is also mentioned in WELL, but is not mandatory."*

The conversations with lighting designers revealed that the lighting levels recommended by WELL are not always appropriate for Dutch workplace spaces. Instead, the NEN12464 standard, listed in WELL but not mandatory, is more suited to creating healthy lighting in these settings. It was discovered that lighting levels in NEN12464 are frequently greater than those recommended by WELL. Experts highlighted that the lower lighting levels specified by WELL frequently result in client complaints, showing that the NEN12464 standard provides healthier lighting in the Dutch setting.

Lighting uniformity is another Key Performance Indicator. The WELL standard recommends a uniformity level of 0.4, although interviews revealed that this level frequently leads to occupant complaints. A uniformity level of 0.6, as recommended for the Dutch workplace context, is considered more beneficial regarding visual comfort. Similarly, the regulations for electric glare in WELL are less strict than those required for a comfortable environment in Dutch offices. The NEN12464 standard contains more extensive standards for minimizing electric glare, making it a better reference for this topic. However, for solar glare, WELL's recommendations were determined to be adequate in preventing discomfort. Regarding other KPIs such as circadian lighting, flicker levels, and colour temperature, the WELL criteria were found adequate and in line with the healthy levels required in the Dutch environment.

Daylighting, which is an important component of occupant comfort, takes several approaches depending on the requirements. While WELL evaluates daylighting using Spatial Daylight Autonomy (SDA), experts believe that this more comprehensive method is helpful in reaching the intended effects. The necessity of appropriate daylighting was underlined, as it is critical for preserving visual and mental comfort in working settings.

> **LD2**: *"Daylight simulation given in BREEAM-NL is way easier than the one given in WELL, however to have healthy daylighting in an office the Spatial Daylight Autonomy given in WELL helps better than the one in BREEAM-NL ."*

Another important feature of visual comfort is the availability of views from the work station, which is not explicitly addressed in WELL or other standards but is critical for occupant well-being. A literature study confirmed the importance of this feature, highlighting the benefits of having access to views, particularly in open-plan offices (Boyce, Hunter, & Howlett, 2003; Heerwagen & Orians, 1986; Veitch, Newsham, Boyce, & Jones, 2008). According to research, vistas can improve well-being and performance, making them an important factor to consider when designing healthy working spaces. D mentions all the selected KPI's with their optimal levels for visual comfort.

Acoustic Comfort

In interviews with acoustic designers, it was advised that the NVBV handbook, written by Dutch specialists, be used for acoustic design in Dutch office environments. This handbook, while not solely concerned with acoustics, provides thorough information on numerous aspects of building design, including acoustics, that are specifically customized to the Dutch setting. The experts noted that

the NVBV-handbook is closely aligned with the acoustic standards necessary to maintain a healthy and productive workplace in the Netherlands.

> **AD1**: *"There is a guideline which is created by experts in the industry in the Netherlands which resonates better with what we call it the healthy acoustic design it is a handboek which we use mostly and also use WELL for a few KPI's like sound absorption values for example ."*

It is also observed that the units WELL uses Rw or STC values are not common in the Netherlands and not exactly comparable too. However, the WELL standard's recommendations for sound-absorbing features, such as the use of acoustical furnishings, were determined to be compliant with Dutch standards. These features greatly reduce noise levels and improve overall acoustic comfort. Furthermore, interviews revealed the significance of including acoustic zoning and sound masking technologies in office designs. The consolidated optimal Acoustic comfort levels for designing healthy office buildings in the Netherlands can be seen in D.

Water

The WELL Building Standard's guidelines on water quality and accessibility were determined to be relevant and suitable in the Dutch setting. The WELL recommendations address crucial factors like as moisture management, ensuring that facilities are designed to prevent water damage and mold growth, both of which can have a negative influence on occupant health. The standard also emphasizes the necessity of having access to safe drinking water, and it establishes explicit water quality guidelines that are consistent with the Netherlands' requirements for healthy working settings.

> **SWBC2**: *"The water quality in the Netherlands is considered good already, any which ways the requirements given for water accessibility and moisture control in the WELL certification is applicable here too, the testing criteria depends from practitioner to practitioner."*

The consolidated for water requirements and moisture control requirements for designing healthy office buildings in the Netherlands can be seen in D.

Safety: Preventing Hazardous Materials and Preventing Hazardous Design

When examining safety in office building design, two critical components are avoiding hazardous materials and establishing safe design methods. During interviews, experts underlined the significance of establishing strict criteria for volatile organic compound (VOC) concentration in building materials to reduce health hazards. The WELL structure Standard recommends that 90% of the cost or surface area of materials fulfil VOC requirements. However, experts caution that focusing on cost may not assure thorough VOC compliance throughout the structure. Instead, they suggested that 75-90% of the surface area of all building materials, including paints, adhesives, and sealants, adhere to the European Union's LCI (Lowest Concentration of Interest) VOC limits to improve indoor air quality in Dutch offices. The restrictions on mercury and lead usage imposed by WELL are appropriate and relevant in the Dutch setting, reducing the danger of exposure to these hazardous compounds.

However, WELL does not provide specific guidance when preventing dangerous design practices. Considerations were drawn from various sources to close this gap, including the (the WBDG Secure / Safe Committee, 2022) (Stokes et al., 2022), and insights from Arizona Corporate Interiors. These sites include useful ideas for designing environments that reduce dangers, such as minimizing sharp edges or protruding features and considering the placement of heavy objects to avoid accidents. The consolidated requirements for preventing hazardous materials and preventing hazardous design for designing healthy office buildings in the Netherlands can be seen in D.

Biophilic Design

The WELL Building Standard includes characteristics of biophilic design. However, its reach is fairly limited, with a concentration on the incorporation of natural materials, patterns, and elements like as plants and water features in general spaces. This method, while advantageous, falls short of fully realizing the potential of biophilic design, particularly in areas such as auditory aspects, multimodal experiences, and the incorporation of natural analogues and privacy measures.The study suggests a more holistic approach to biophilic design reinforced by well-cited literature, including visual linkages to nature, the importance of producing soundscapes, multisensory experiences, and designing spatial layouts replicating natural landscapes (Alvarsson, Wiens, & Nilsson, 2010; Becker & Steele, 1995; Joye & Dewitte, 2018). These additional tactics seek to create an immersive and healing atmosphere that dramatically improves occupant well-being. By emphasizing sensory aspects of biophilic design, such as incorporating natural noises or utilizing materials that engage many senses, office environments can become more than just physically beautiful; they can actively contribute to mental health, productivity, and overall enjoyment (Bringslimark, Hartig, & Patil, 2009; Kaplan, 1995; Nicol & Humphreys, 2002).

The larger, more nuanced approach from the literature (Gozalo, Morillas, González, & Moraga, 2018; Heerwagen & Orians, 1986) provides a richer, more full integration of biophilic design concepts, going beyond the simple addition of natural components to foster surroundings that promote occupants' overall well-being . The consolidated list of requirements can be seen in the D. This comprehensive strategy not only improves the aesthetic and functional quality of office spaces but it also significantly impacts the mental and emotional well-being of those who work in them, resulting in better health, productivity, and overall workplace satisfaction. The consolidated requirements for biophilic design for designing healthy office buildings in the Netherlands can be seen in D.

Personal control

Using user-friendly interfaces, the WELL Building Standard stresses personal control by allowing occupants to modify ambient factors such as lighting, temperature, and air quality. However, other research considerations could also be incorporated to build a more comprehensive and effective norm. Both the WELL guidelines and literature (Becker & Steele, 1995; Kim & De Dear, 2012; Kwon, Remøy, Van Den Dobbelsteen, & Knaack, 2018)emphasizes the necessity of more granular control over thermal comfort, such as individualized heating and cooling systems and moveable windows, which give occupants greater flexibility and adaptability to their immediate surroundings.Furthermore, the findings shows that control mechanisms should be created for smaller groups

(2-6 individuals) in order to avoid conflicts over shared environmental settings while also better accommodating individual preferences. Specific equipment, such as CO_2 monitors and personal air purifiers, that provide real-time feedback and improve air quality control are also advised (Brager, Paliaga, De Dear, & Humphreys, 2004; Kwon et al., 2018; Pan et al., 2018).

In terms of privacy, WELL makes no explicit mention of the usage of privacy controls such moveable partitions or plant-based dividers, which the literature sees as vital for offering flexibility in workspace design. Incorporating these factors could considerably increase WELL's effectiveness in creating a personalized and adaptive environment that improves occupant comfort, contentment, and overall well-being. The consolidated optimal personal control considerations for designing healthy office buildings in the Netherlands can be seen in D.

Spatial quality:

The WELL Building Standard establishes a basic framework for establishing healthy working settings, but it lacks precise guidance on designing spaces that encourage collaboration and interaction—crucial components for boosting teamwork and innovation. The benchmark could be raised by including particular solutions for diverse work environments, space efficiency, and flexible office architecture. These components are critical for enabling various types of work and ensuring seamless transitions between independent tasks and collaborative efforts.

The literature (De Croon, Sluiter, Kuijer, & Frings-Dresen, 2005; Duffy, Jaunzens, Laing, & Willis, 2003; T. J. Van Der Voordt, 2004; Vischer, 2007; Vischer & Wifi, 2016)provides significant insights that can supplement the WELL framework by taking into account flexible workspaces, collaborative environments, and techniques that promote movement and engagement in the workplace. These tactics are especially crucial in building workplaces that promote both physical and mental health by allowing employees to move freely, interact efficiently, and tailor their workspaces to their personal requirements. By incorporating these extra design ideas into the WELL framework, office spaces can encourage a more balanced and productive workplace that responds to the different requirements of its occupants. The consolidated considerations for spatial quality for designing healthy office buildings in the Netherlands can be seen in D.

Accessibility

The WELL Building Standard recognizes the importance of accessible and universal design, although it lacks specific concerns. In contrast, BREEAM-NL uses NEN 1814 in new construction and also mentions some important KPIs in the BREEAM-NL In-Use Utility Construction V6.0.0 (*NEN 1814:2001 nl*, 2001; V6.0.0, 2020), which includes full accessibility criteria for people with disabilities (PwD), such as access to facilities, essential access points, and appropriate signage. NEN 1814 ensures that all areas of an office building are accessible, hence considerably improving tenant well-being. Incorporating these specific guidelines into Dutch office design respects legal requirements and promotes inclusivity, resulting in a healthy and supportive atmosphere for all employees.

The current practice of designing healthy office environments in the Netherlands involves adhering to the WELL Building Standard, which provides a solid framework for many health and well-being metrics. However, relying solely on WELL may not fully meet requirements specific to Dutch

indoor office environments. As observed, some of WELL's thresholds and guidelines may not align with local contexts. Thus, designing a healthy office building in the Netherlands requires combining the WELL guidelines with other frameworks, such as Gezonde Kantooren and the NVBV handbook, BREEAM-NL, etc which have been tailored to Dutch conditions. These additional guidelines ensure that all health performance indicators are met at optimal levels, resulting in spaces promoting occupant well-being while adhering to Dutch building regulations and expert recommendations. The consolidated considerations for accessibility for designing healthy office buildings in the Netherlands can be seen in D.

5.4 Project stages and processes

After choosing the foundational elements and KPIs and analyzing their applicability to the Dutch context, the next step is to understand the project process, including the various stages, considerations, and stakeholder engagement. A basic understanding of the activities in each phase was obtained through an interview with a well-being consultant, which is summarized in Appendix A. Based on the insights gained from this interview and the selected KPIs outlined in Appendix C, considerations for each phase were developed to ensure that the selected KPI levels are met by the end of the project. These considerations were then validated in an interactive session with three sustainability and well-being consultants, who discussed and refined the considerations and KPIs.

5.4.1. Project Definition Phase

Stakeholders involved: The client representative (CRE), Health, Well-being, and Building Consultant (HWBC), Facility Management (FM), Occupant Survey Representative or Administrator, and HR/Workplace Management are key participants in this phase.

Table 5.5: Project Definition Phase Activities

Activity	**Description**	**Stakeholder Responsible**
Conduct Occupant Survey	Perform a survey to gather insights on occupant well-being requirements and preferences	Client team
Establish Project Goals	Collaborate with all stakeholders to define and set the well-being goals for the project	Client team, Well-being experts, and other stakeholders involved
Form a Well-Being Definition	Develop a clear, tailored well-being definition to guide the project's design and objectives	Well-being experts, Client team
Client Representative Distributes Goals	Communicate the finalized project goals to the design team and other stakeholders	Client team
Review the Vision	Review the vision for the project and add comments by the Well-being consultant	Well-being consultant

5.4.2. Brief Preparation Phase Activities

Stakeholders involved: The project team (client representative), Well-being, and Building Consultant (WBC), Design Team (Architect, MEP Designer, Lighting designer, Acoustic designer), and Facility Management (FM) are key stakeholders in this phase.

Table 5.6: Brief Preparation Activities

Activity	**Description**	**Stakeholder Responsible**
Translate the Project's Vision	Translate the overall project vision and goals into actionable guidelines for the design and execution phases	Well-being consultant
Select KPIs for Foundational Elements	Choose the Key Performance Indicators (KPIs) for each foundational element (e.g., air quality, thermal comfort)	Well-being consultants, MEP designer, architect, building physics consultants, and other relevant stakeholders (FM)
Send the Brief to Relevant Stakeholders	Ensure the finalized brief is shared with all relevant stakeholders, including the well-being consultant	Well-being consultants
Integrate Selection into Project's Plan	The client team integrates the selected KPIs and goals into the broader Program of Requirements	Client team
Review the Brief and POR	Review the brief and Program of Requirements for the project and add comments for further steps	Well-being consultant

5.4.3. Schematic Design Phase Activities

Stakeholders Involved: Architect, Health and Well-being Consultant, MEP designer, lighting designer, acoustic designer, project team (client representative).

Table 5.7: Schematic Design Phase Activities

Foundational Element	**KPI**	**Schematic Design Requirements**	**Stakeholder Responsible**
Indoor Air Quality	CO_2 Range	Ventilation calculation for air volume based on CO_2 levels	MEP designer
	Air Permeability	Evaluate structural options to meet air permeability targets	MEP designer
Thermal Comfort	Temperature & Humidity	Define broad HVAC zoning requirements for temperature and humidity	MEP designer
Visual Comfort	Daylight	Ensure zoning for areas requiring access to daylight	Architect, lighting designer
	Views from Desk	Ensure "Views from Desk" are considered, prioritizing pleasant views	Architect, lighting designer
Acoustic Comfort	Sound Insulation Between Rooms	Zoning for spaces requiring sound insulation (e.g., offices, meeting rooms), critical areas for reverberation time and determine zones that require higher speech privacy	Architect, acoustic designer
	Sound Insulation from Outside Noise	Analyze the contextual noise to determine the requirements for the façade	Architect, lighting designer
Water Quality	Accessibility to Drinking Water	Identify key areas where drinking water access will be needed (e.g., break rooms)	Architect, well-being consultant
Accessibility	Circulation	Conceptualizing to include accessible facilities in the building design	Architect, well-being consultant
Biophilic Design	Visual Connection to Nature	Broad zoning to prioritize areas with views to nature	Architect
Spatial Quality	Active Office Design	Create a general zoning plan that identifies areas for key facilities (restrooms, kitchens, breakout spaces), ensuring they are placed to encourage movement throughout the building	Architect
	Flexible Office Design	Define zones for open-plan workspaces and private areas to support collaboration and focused work	Architect
-	Review Implementations	Review all implementations and revisions in zoning and considerations and provide comments	Well-being consultant

5.4.4. Concept Design Phase activities

Stakeholders involved: Architect, Health and Well-being Consultant, MEP designer, lighting designer, acoustic designer, project team (client representative), Structural engineer.

Table 5.8: Concept Design Phase Activities - Part 1

Foundational Element	**KPI**	**Concept Design Requirements**	**Stakeholder Responsible**
Indoor Air Quality	CO_2 Range	Refine ventilation strategies by adjusting air volume requirements based on detailed occupancy numbers and space utilization	MEP designer
Indoor Air Quality	Air Permeability	Evaluate structural design options for meeting air permeability targets	MEP designer
Thermal Comfort	PMV Range	Run Vabi simulations to evaluate thermal comfort and adjust PMV targets	MEP designer
Thermal Comfort	Temperature & Humidity	Update ventilation and HVAC calculations based on occupancy and design requirements	MEP designers
Thermal Comfort	Air Velocity	Ensure air velocity calculations meet comfort targets based on space utilization and occupancy	MEP designers
Visual Comfort	Lighting Level	Perform detailed lighting calculations to ensure compliance with lux levels, uniformity, and brightness per the brief	Lighting designers
Visual Comfort	Type of Light Fixtures	Specify types of light fixtures focusing on energy efficiency, color temperature, and glare reduction	Lighting designers
Visual Comfort	Circadian Lighting	Identify spaces where circadian lighting would be beneficial and support well-being	Lighting designers
Acoustic Comfort	Acoustic Zoning	Conduct preliminary acoustic screening to identify zones needing enhanced sound control	Acoustic designers
Acoustic Comfort	Reverberation Time	Carry out checks for reverberation time in spaces critical for sound absorption	Acoustic designers
Acoustic Comfort	Sound Insulation from Façade	Perform initial calculations and conceptualize facade treatments to mitigate external noise if near noisy areas	Acoustic designers
Water Quality	Accessibility to Drinking Water	Zone the placement of water points to ensure accessibility and compliance with health standards	Well-being consultant
Water Quality	Moisture Control	Zone areas likely to experience water exposure and plan general moisture control strategies	Architects, MEP designers

Table 5.9: Concept Design Phase Activities - Part 2

Foundational Element	KPI	Concept Design Requirements	Stakeholder Responsible
Water Quality	Water-Resistant Materials	Identify areas needing water-resistant materials and zone moisture-prone areas	Architects, MEP designers
Safety	Space Planning & Accessibility	Ensure the layout adheres to safety and accessibility regulations, especially corridor widths and emergency egress routes	Architects
Safety	Preventing Flooring & Trip Hazards	Identify zones with higher risks of slips or trips and plan anti-slip flooring materials	Architects
Safety	Security Measures	Integrate security measures and design entrances to minimize exposure to uncontrolled vantage points	Architects
Biophilic Design	Visual Connection to Nature	Develop plans for integrating biophilic features such as windows, natural materials, and spaces for plant installations	Architects
Spatial Quality	Active Office Design	Develop a layout to promote movement by strategically placing stairs, kitchens, and other facilities	Architects
Spatial Quality	Flexible Office Design	Incorporate a mix of open-plan areas and private spaces for focused work and collaboration	Architects
Spatial Quality	Interaction & Collaboration	Design circulation paths to minimize congestion and create spaces for interaction	Architects
Spatial Quality	Restorative Spaces	Develop the layout to incorporate restorative spaces based on occupancy	Architects
Personal Control	Thermal & Lighting Control	Integrate personal control systems for lighting and HVAC, ensuring controls cover approximately 5-10 m^2 per occupant	Architects, MEP designers
Accessibility	Circulation & Access Routes	Ensure step-free access, sufficient corridor widths, accessible entrances, and elevator placements	Architects
-	Review Implementations	Review all zoning, initial design, and provide comments	Well-being consultant

5.4.5. Detail Design Phase Activities

Stakeholders involved: Architect, Health and Well-being Consultant, MEP designer, lighting designer, acoustic designer, project team (client representative), Structural engineer, contractor, Facility Manager

Table 5.10: Detail Design Phase Activities - Part 1

Foundational Element	**KPI**	**Detail Design Requirements**	**Stakeholder Responsible**
Indoor Air Quality	Air Filters	Specify air filters and select based on particulate matter (PM2.5 and PM10) control requirements	MEP Designer
Thermal Comfort	PMV Range	Run Vabi simulations to refine PMV targets based on updated design	MEP Designer
Visual Comfort	Lighting Level	Perform detailed lighting calculations for all spaces	Lighting Designer
Visual Comfort	Light Fixture Specifications	Define and specify lighting fixture types (including color temperature, glare, flicker control) based on project brief and lighting requirements	Lighting Designer
Visual Comfort	Circadian Lighting	Perform detailed lighting calculations to ensure that workstations receive light levels of 150-275 EML (or 136-250 melanopic EDI) for at least four hours per day. Ensure the lighting system supports both functional and biological needs.	Lighting Designer
Acoustic Comfort	Sound Insulation Between Rooms	Finalize acoustic performance specifications for partitions, walls, and doors.	Acoustic Designer
Acoustic Comfort	Reverberation Time	Ensure sound-absorbing materials are specified in spaces with high reverberation potential.	Acoustic Designer
Acoustic Comfort	Sound Absorbent Features	Consider the NRC values and sound absorbent features for different zonal acoustical requirements, as mentioned in the brief.	Acoustic Designer
Acoustic Comfort	Sound Insulation from the Facade	Initial calculations and conceptualizing the façade treatment for noise control if the site is near noisy areas	Acoustic Designer

Table 5.11: Detail Design Phase Activities - Part 2

Foundational Element	KPI	Detail Design Requirements	Stakeholder Responsible
Water Quality	Detailing of Facade/Envelope	Incorporate strategies like capillary breaks, drainage systems, and vapor barriers into the design. Include provisions for managing condensation.	MEP Designer
Water Quality	Moisture Control	Plan for moisture-resistant designs in identified areas, incorporating capillary breaks and vapor barriers.	MEP Designer
Water Quality	Water-Resistant Materials	Define the specifications for water-resistant materials in moisture-prone areas identified in the conceptual design phase.	MEP Designer
Safety	Space Planning and Accessibility	Finalize space planning to ensure clear, unobstructed access to emergency exits with well-marked exit routes.	Architect
Safety	Buffered Electrical Services	Ensure electrical services are placed at least 500 mm from circulation paths and between 900 mm and 1200 mm from the floor.	MEP Designer
Safety	Preventing Flooring and Trip Hazards	Define specifications for slip-resistant flooring materials in moisture-prone areas.	Architect
Safety	Security Measures	Detail security measures such as controlled access points, alarms, and surveillance systems.	Architect
Biophilic Design	Biophilic Design Elements	Specify the placement and integration of key biophilic features such as natural materials, windows for outdoor views, plant installations, and multisensory elements.	Architect
Spatial Quality	Active Office Design	Finalize placement and specifications for key facilities to encourage movement and accessibility.	Architect
Spatial Quality	Flexible Office Design	Define specifications for partitions in flexible zones to support various work modes.	Architect
Spatial Quality	Spaces to Enhance Interaction	Ensure detailed designs for circulation paths to enhance flow and minimize congestion, and finalize collaborative space layouts.	Architect
Personal Control	Thermal & Lighting Control	Define specifications for control systems for lighting and thermal comfort in specified zones.	MEP Designer

Table 5.12: Detail Design Phase Activities -part-3

Foundational Element	KPI	Detail Design Requirements	Stakeholder Responsible
Accessibility	Circulation and Access	Finalize design for circulation routes, access points, and facilities, ensuring step-free access, door widths, accessible toilets, and emergency routes meet accessibility standards.	Architect
Accessibility	Circulation, Access, Wayfinding	Define specifications for accessible elements such as step-free access, door widths, handrails, accessible toilets, and clear signage to meet accessibility standards.	Architect
-	Review Implementations	Review all zoning, design, and considerations and provide comments.	Well-being consultant

5.4.6. Technical Design Phase Activities

Stakeholders involved: Architect, Health and Well-being Consultant, MEP designer, lighting designer, acoustic designer, project team (client representative), Structural engineer, contractor

Table 5.13: Technical Design Phase Activities - Part 1

Foundational Element	KPI	Technical Design Requirements	Stakeholder Responsible
Indoor Air Quality	CO_2 Range	Specification and selection of CO_2 sensors and alarm thresholds	MEP Designer
Indoor Air Quality	Air Filters	Verify that the selected air filters meet air quality and particulate matter removal standards	MEP Designer
Thermal Comfort	Air Velocity	Verify the air velocity control systems to ensure compliance with thermal comfort targets	MEP Designer
Thermal Comfort	Thermal Comfort	Define and finalize the specifications for HVAC systems, ventilation, and air velocity controls based on thermal comfort targets to maintain consistent temperature, humidity, and air velocity	MEP Designer
Visual Comfort	Lighting Level	Update lighting calculations based on any design changes	Lighting Designer

Table 5.14: Technical Design Phase Activities - Part 2

Foundational Element	KPI	Technical Design Requirements	Stakeholder Responsible
Visual Comfort	Light Fixture Specifications	Verify specifications and selection of light fixtures, including color temperature, glare, and flicker control	Lighting Designer
Visual Comfort	Circadian Lighting	Specify circadian light fixtures and finalize the control systems	Lighting Designer
Acoustic Comfort	Sound Insulation Between Rooms	Verify that the selected partitions, doors, and walls meet sound insulation standards.	Acoustic Designer
Acoustic Comfort	Sound Absorbent Features	Verify NRC values and sound absorbent features to meet zonal acoustical requirements.	Acoustic Designer
Acoustic Comfort	Sound Insulation from Facade	Drawings for the façade treatment to be evaluated to finalize construction phase requirements	Acoustic Designer
Water Quality	Water-Resistant Materials	Verify the specifications and select water-resistant materials for moisture-prone areas such as basements, bathrooms, and kitchens	MEP Designer
Water Quality	Moisture Control	Finalize installation details for moisture control systems, including drainage systems and vapor barriers. Ensure proper implementation	MEP Designer
Safety	VOC Thresholds	Verify material specifications and select materials to meet VOC thresholds as per regulations	Architect and Contractor
Safety	Compliance Testing for Materials	Ensure the selection of third-party tested materials in line with defined ambitions	Architect and Contractor
Safety	Mercury Thresholds in Equipment	Verify that all electrical equipment meets mercury threshold requirements	MEP Designer and Contractor
Safety	Lead Thresholds in Paints and Finishes	Check and verify lead thresholds in paints and finishes are compliant with project specifications	Architect and Contractor
Biophilic Design	Visual Connection to Nature	Finalize placement and specifications for biophilic features like natural materials, large windows for outdoor views, plant installations, green walls, and multisensory elements	Architect and Contractor

Table 5.15: Technical Design Phase Activities - Part 3

Foundational Element	KPI	Technical Design Requirements	Stakeholder Responsible
Accessibility	Circulation	Verify circulation route specifications meet accessibility standards (e.g., widths, slope inclinations)	Architect and Contractor
Accessibility	Key Access Points	Finalize specification for key access points, ensuring step-free access, wide doors, and handrails for ramps and steps	Architect and Contractor
Accessibility	Access to Facilities	Confirm all facilities (toilets, drinking water taps, showers) meet accessibility requirements, including controls such as switches and handles at appropriate heights	Architect and Contractor
Personal Control	Thermal & Lighting Control	Verify system design for zonal and individual control systems for lighting and thermal comfort	MEP Designer and Contractor
Spatial Quality	Active Office Design	Ensure facilities such as restrooms, kitchens, and breakout spaces are placed at appropriate distances to encourage movement	Architect
Spatial Quality	Flexible Office Design	Confirm private and open-plan spaces are appropriately mixed, and ensure multifunctional spaces with adjustable partitions are finalized	Architect
Spatial Quality	Restorative Spaces	Finalize breakout spaces and wellness areas, ensuring at least one breakout space per 20 employees	Architect
-	Review Implementations	Review all implementations and revisions in design and considerations and provide comments for the next phase	Well-being Consultant

5.4.7. Construction Phase Activities

Stakeholders involved: Architect, Health and Well-being Consultant, MEP designer, project team (client representative), contractor

Construction Phase requirements:

1. Ensure implementation is in line with the Detail design phase and Technical Design phase for all the foundational elements and their KPIs.
2. Ensure that all materials used meet the required safety standards, such as VOC thresholds, lead content, and other hazardous material limits.
3. Ensure that all accessibility features (ramps, door widths, elevators, and accessible controls) are installed according to specifications and compliant with accessibility standards.

4. Well-being expert to review all implementations and provide comments for the handover phase.

5.4.8. Handover Phase Activities

Stakeholders involved: The client representative (CRE), Well-being Consultant, Facility Management (FM), Occupant Survey Representative or Administrator, HR/Workplace Management and Commissioning team are key participants in this phase.

Table 5.16: Handover Phase Activities

Phase Activity	**General Requirements**	**Stakeholder Responsible**
Commissioning	Conduct thorough commissioning of all building systems (HVAC, lighting, acoustics, water, etc.), ensuring all systems function as intended and meet the project brief, including sensor calibration, performance verification, and safety checks.	Commissioning Team
Final System Calibrations	Calibrate all systems (especially sensor-based requirements like air quality sensors). Perform on-site readings and compare them with instrument readings to ensure accurate performance during the commissioning process.	Commissioning Team and Calibration Technicians
Final Walkthrough and Punch List	Perform a final walkthrough with the client to address any outstanding issues and generate a punch list for final adjustments or corrections.	Well-being Expert, Architect, Contractor
As-Built Documentation	Provide as-built drawings and documentation to the client, reflecting any changes made during the construction process.	Architect
Building Handover	Officially hand over the building to the client, ensuring that all contractual obligations have been met and verified.	Contractor
Handover Document	Provide a manual/handover document for the operation phase, detailing how to maintain the installations and building parts from the contractor's side.	Architect and Contractor

5.4.9. Stakeholder Involvement Current Vs Ideal for designing healthy office building

The two images 5.1 **??** illustrate differences in stakeholder involvement when designing a healthy office building and the current involvement of stakeholders in office design projects. In current processes, stakeholders such as and the building physics consultant are only involved during critical design stages, such as conceptual design, detail design, and technical design. However, in a healthy office design, these consultants are involved at almost every stage, ensuring that well-being and sustainability principles are consistently integrated. Furthermore, in traditional projects, facility management is usually only involved during the handover stage. However, for a healthy office design, their involvement begins earlier, first during the project definition phase, then during the later phases, allowing operational considerations to influence design decisions and ensure the longevity of health-oriented design elements. Another significant addition is the occupant feedback representative aspect, which helps incorporate all the stakeholders' needs.

In terms of design considerations, design process of a healthy office building focuses on proactive decision-making for environmental factors such as air quality, lighting, thermal comfort etc, ensuring that the office environment promotes occupant health from the start. The continuous involvement of experts such as MEP designers and building physics consultants ensures that critical systems (for example, HVAC and lighting) are designed to meet specific well-being Key Performance Indicators (KPIs). Designing a healthy office building is more holistic, requiring interdisciplinary collaboration throughout the design and construction phases to create environments that promote long-term well-being.

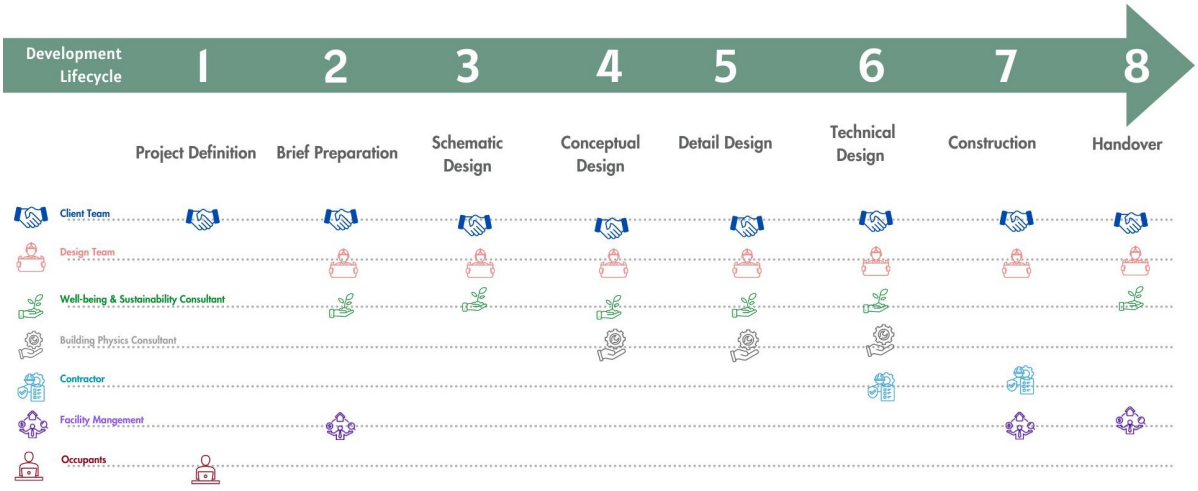


Figure 5.1: Stakeholder Involvement: Current Processes.(Own work).

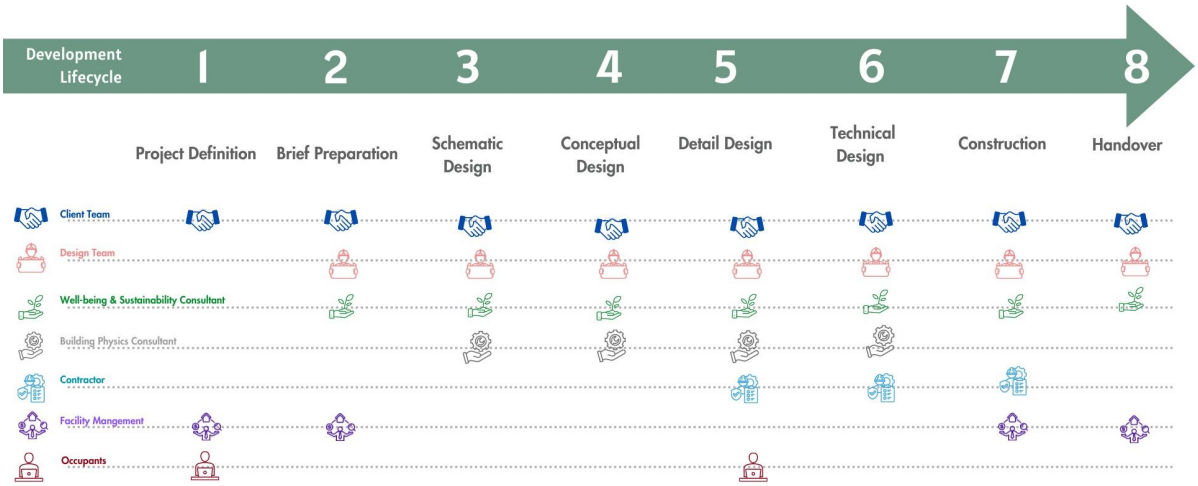


Figure 5.2: Stakeholder Involvement: Ideal for Design of a healthy office building.(Own work).

5.5 Challenges for Integration

Developing healthy indoor office environments involves multiple challenges, many of which have been identified through interviews with important stakeholders in the Dutch AEC industry. These challenges, based on the perspectives of experts involved in many parts of office building design and management, which highlight the complexity and necessity for tailored solutions that are in line with global standards and local situations.

5.5.1. Complexity and Administrative Burden of WELL Certification

One of the most commonly reported challenges is obtaining WELL certification's complexity and administrative burden. The process is overwhelming because of the substantial paperwork and the large number of features (about 100) that must be controlled. This can be especially difficult for clients who struggle to select what is most relevant to their project. It might be overwhelming and gives rise to doubts about the usefulness of certification (SWBC2, CRE1, C1).

> **CRE1**: *"Most times we pick the features from WELL that makes sense to us and incorporate them without going for certification because the process comes with a lot of administrative burden also is resource intensive and it also has around 100+ features which can also be overwhelming for our team at times."*

C1, AR1, FM1 and LD1 shared similar sentiments.

5.5.2. Relevance of WELL Features in the Dutch Context

Several stakeholders noted that not all WELL aspects are applicable or necessary in the Dutch setting. For example, local legislation already requires a prohibition on asbestos and smoke-free spaces, making these parts of WELL appear unnecessary (SWBC2). It is also pointed out that although

the WELL certification comprises the most significant themes and offers the optimal levels for the topics, not all are valid for the Dutch building environment (LD1, CRE1).

> **SWBC2**: *"If we take a look at few of the features of WELL like thresholds for asbestos or avoiding asbestos, and for water testing threshold for fluoride which is already banned in the Netherlands, so such requirements seem irrelevant."*

> **LD1**: *"If we see the WELL requirements and abide by it, we have also experienced that clients complain about discomfort, so not all the requirements suit our context. One example is lighting uniformity levels; there is a difference between the healthy lighting uniformity level in our context and the one mentioned in WELL."*

5.5.3. Balancing Global Standards and Local Practices

Implementing consistent well-being strategies across areas is another big difficulty. Cultural differences, local rules, and varied expectations may prevent what works well in the Netherlands from being as effective in other regions, such as China. The absence of a one-size-fits-all solution challenges efforts to maintain uniform well-being standards across worldwide office locations (CRE1).

> **C1**: *"For our company there is a lack of a unified well-being strategy and WELL does not help us with that because it does not take into account the complexity of cultural differences, local rules and diverse expectations, so there is always a necessity to set up a strategy per project."*

5.5.4. Perceived Well-Being versus Actual Design

The perceived well-being of occupants frequently differs from the actual design of office environments. Thermal comfort levels, for example, may be comfortable for one group of occupants but not for another, especially in international situations where comfort preferences differ. Furthermore, behavioural aspects, such as how occupants use the space, might influence well-being, making it difficult to create a space that meets everyone's needs (AR2, SWBC2, MEP1).

> **AR2**: *"One common challenge would be the difference between design and how users perceive the design, there's always an effort that goes in design towards finding a middle ground to balance that and also designing considering most requirements from stakeholders and occupants."* MEP1, SWBC2, C1 also shared similar opinions about this challenge.

5.5.5. Engagement and Communication Issues

Effective communication and education are essential when implementing WELL standards, although they can be difficult due to the certification process's complexity. Ensuring all stakeholders understand the requirements and their implications is critical but difficult, especially in larger projects involving several partners.

> **SWBC2**: *"Now we know that this process involves a lot of stakeholders, aligning all their objectives and keeping up with them throughout the design process where things constantly keep revising is complex, engaging stakeholders regularly and keeping them updated with all the changes is very important but is also a difficult endeavor."*

5.5.6. High Cost and Resource Demands

The financial and resource requirements for obtaining WELL certification are high, making it a pricey venture. This is especially true when attempting to defend the investment in WELL certification versus other possible uses of cash within a company. At times, the focus shifts on attaining a certification rather than focusing on the health and well-being goals (CRE1).

> **C1**: *"The process of WELL certification involves onsite performance testing, which carries additional costs. And consulting fees are seen to be at a higher end. The higher cost is a major reason WELL is generally perceived as "high-end" in the marketplace, but it can also make it unfeasible for many assets. Because of that sometimes the goal of attaining certification becomes more important than the reason we thought to go for the certification."*

5.5.7. Lack of Flexibility in WELL Certification

WELL certification is sometimes perceived as lacking flexibility, making it difficult to apply equally across various working environments. This rigidity can make adapting WELL standards to meet organizational demands or unique building environments difficult, particularly when local legislation or practices differ from those envisioned by WELL standards (FM1, AR2, LD2).

> **FM1**: *"There are a few requirements in WELL which I think restricts us as clients and the architects too, to explore different creative possibilities for provisions of certain facilities take for example frequency of water points, I think this must be up for interpretation based on user requirement and zoning design of the project."*

5.5.8. Cultural and Behavioral Barriers

Cultural and behavioural issues may provide considerable challenges to successfully implementing well-being programs. Even if venues are intended to promote well-being, employees may not use them properly due to cultural conventions or personal discomfort. This can result in under utilising well-being features, reducing their effectiveness (CRE1, AR1, SWBC1).

> **CRE1**: *"The requirements in WELL for mind, active design strategies like physical activity spaces and community differ from our HR, work place management policy and the unique organizational culture which is tailor made for our offices, I think this also might be because the certification is set in the US and the cultural differences cause that."*

5.5.9. Challenges of Aligning WELL with Organizational Culture

Implementing WELL standards might be problematic if they do not fit an organization's culture (as mentioned in the previous quotation). Some WELL standards, particularly those connected to HR regulations, may not mesh easily with existing practices, resulting in friction and resistance during adoption (FM1, AR1, CRE1).

5.5.10. Lack of Process-based approach

In addition, respondents noted that while current frameworks and recommendations such as WELL set high requirements for occupant well-being, they do not always provide clear direction on how to execute these standards at each stage of the project process.

> **SWBC2**: *"One important thing to note could be that all the current guidelines in place helps us derive a project goal with high ambitions but they do not necessarily help guide through the process because it has differential requirements, it is important to have considerations for project stages that needs to be kept in mind while designing a healthy building."*

CRE1, LD1, AD1, AR2 also shared similar sentiments and highlighted the need for a process-based approach

As seen in the previous section about the applicability of guidelines to the Dutch context features in WELL, such as air quality or thermal comfort, frequently do not apply in the Dutch setting. Instead, standards such as Gezonde Kantooren(Hensen Centnerová et al., 2021) for air quality and thermal comfort, NEN12464 (*NEN-EN 12464-1:2021 en*, 2021)for lighting, the NVBV Handbook (van der Linden & Vereniging, 2023) for acoustics and NEN1814 (*NEN 1814:2001 nl*, 2001) for accessibility standards are often employed in the Netherlands to create healthy office settings. These problems highlight the need for a tailored strategy that establishes high well-being criteria and provides practical assistance on meeting these goals in Dutch office buildings. By addressing these issues, the development of healthy workplace environments in the Netherlands can be better aligned with global well-being goals and local realities, resulting in places promoting their occupants' health and well-being.

5.6 Approach to Address Challenges

The interviews revealed a pressing need for a tailored approach that addresses the specific contextual requirements of Dutch office buildings. This approach would mitigate the challenges currently posed by the extensive administrative burden of the WELL certification process. By focusing on creating healthier office environments that align with Dutch standards and organizational culture, this approach aims to streamline the process while maintaining the rigor of health and well-being standards. A recurring theme in the interviews was the necessity for an approach supporting the development of a comprehensive well-being strategy throughout the project lifecycle. While the WELL guideline is widely recognized for setting a vision for healthier office environments, it falls short in offering actionable guidance across the different stages of a project. This gap suggests the

need for a framework that sets a vision and provides clear, context-specific design considerations at each project stage [SWBC2].

The challenge of perceived well-being versus actual well-being, highlighted in the interviews, underscores the complexity and subjectivity inherent in this field since needs are endless. That kind of subjectivity can be complex. An effective approach that addresses meeting common stakeholder expectations while considering the specific context, including the perspectives of potential occupants, can help achieve an efficient, if not the ideal, solution.

Given the scope of this research, the proposed approach will focus on developing a framework tailored to the context of Dutch buildings. This framework will provide a process guide through the design stages of a project, offering design considerations specific to each stage. Such a framework would serve as a practical tool, organizing information systematically, making it easier to interpret and apply in developing healthy office buildings(Wallace & Projects, 2015). This structured approach is essential for ensuring that the unique needs of Dutch office environments are met effectively and efficiently.

Table 5.17: Themes and Codes from Thematic Analysis for Challenges in Integration

Theme	Code	Description
Complexity and Administrative Burden	WELL Certification Complexity	Challenges in managing the extensive documentation and tracking required for WELL certification.
	Administrative Overhead	The significant time and effort required to manage WELL certification processes.
Contextual Relevance	Relevance of WELL in the Dutch Context	The relevance and applicability of WELL features within the Dutch context, where some features are considered redundant.
	Redundancy of Certain WELL Features	Certain WELL features are seen as unnecessary in the Dutch context due to existing local regulations.
Global vs. Local Practices	Standardization Challenges	Difficulty in applying standardized well-being practices across different global regions, particularly in aligning with local practices and needs.
	Cultural and Regulatory Differences	The challenge of implementing global standards in regions with different cultural norms and regulatory environments.
Perceived Well-Being vs. Actual Design	Perceived Comfort vs. Actual Comfort	The disconnect between what occupants perceive as comfortable and the actual design of the office environment.
	Behavioral Impact on Well-Being	The impact of occupants' behaviors on the effectiveness of well-being features, such as how spaces are used.
Communication and Engagement	Stakeholder Communication Challenges	The difficulty in ensuring clear communication and understanding among stakeholders about WELL requirements and their implications.
	Education on WELL Requirements	The need for educating stakeholders about the complexities of WELL certification to ensure successful implementation.
Resource Demands	Cost of WELL Certification	The high financial and resource costs associated with achieving WELL certification.
	Resource Intensity	The significant resources required to implement and maintain WELL certification.
Flexibility in Standards	Lack of Flexibility in WELL Standards	The rigidity of WELL certification, making it difficult to adapt to specific organizational needs or building contexts.
	Adaptation Challenges	Challenges in adapting WELL standards to local or organizational specificities, particularly in the Dutch context.
Organizational Culture	Cultural Barriers	The resistance encountered when WELL standards conflict with established organizational practices or cultural norms.
	Misalignment with Organizational Practices	The difficulty in aligning WELL standards with the existing culture and practices within an organization.
Dutch-Specific Standards	Local Standards vs. WELL Standards	The preference for local standards such as Gezonde Kantoren over WELL standards for specific aspects like air quality and lighting.
	Need for Dutch-Specific Guidelines	The need for a more tailored guideline that fits the specific needs of Dutch office environments.

6

Developing a Tailored Framework for Well-Being Integration in Office Buildings

This chapter describes the development of a framework after recognizing the need for a tailored approach, which was determined through detailed stakeholder interviews and content analysis of building codes and current practices (WELL guidelines). This framework aims to address the specific challenges discussed in the previous chapter.
The development approach included a review of current guidelines in practice and the mandatory requirements, such as the WELL Building Standard and Dutch building codes, to identify areas where existing frameworks fell short. Interviews with industry experts offered crucial insights into the specific needs and conditions relevant to the Dutch context. These findings influenced the development of a framework that incorporates critical foundational elements that impact occupant health and well-being, adapts procedures to local standards and cultural expectations, and adheres to the Dutch Building Code requirements.In addition this chapter helps answer the **SQ4**.

The framework is intended to provide a structured approach with design considerations for each project stage, ensuring that health and well-being are prioritized throughout the design stages of office building projects in the Netherlands. The objective is to give a clear, accessible representation of Key performance indicators and design requirements, allowing for more effective implementation and collaboration among stakeholders. This framework marks an important step towards creating healthier, more efficient office spaces since it addresses both the gaps noted in existing frameworks and the specific requirements of Dutch office environments.

6.1 Vision for the Framework

The concept for this framework is based on insights collected from stakeholder interviews and an analysis of existing guidelines for designing healthy office buildings. Each element in the framework's vision is based on these findings, ensuring that it addresses specific challenges and requirements during the research.

- **Holistic Integration:** The framework aims to incorporate fundamental elements like air quality, thermal comfort, visual comfort, etc., into a unified design approach that encourages occupant health and well-being.

> **SWBC2**: *"Focusing on a single element—such as air quality or thermal comfort—is usually not enough to get the desired result for a healthy building, a truly healthy office must integrate all elements, from air quality and thermal comfort to visual comfort and biophilic design."*

- **Contextual adaptation:** It seeks to modify design methodologies by regional building codes and cultural norms to meet particular contextual needs while addressing the specific requirements of Dutch office buildings. This is to address the challenge of balancing global standards and local practice and the relevance of WELL features in the Dutch context 5.5.3.
- **Project Stage-Specific Design Considerations:**The framework will include specific design considerations for each design stage of an office building project, from the pre-design phase to construction and handover, ensuring a consistent emphasis on health and well-being. This is to address the challenge that the current guidelines in use to create healthy offices helps set a project vision and doesn't mention considerations for each phase.5.5.10
- **Simplified depiction:** It will provide a clear and accessible representation of the project's foundational elements and KPIs, allowing stakeholders to interpret and implement them easily.
- **Enhanced Collaboration:** By offering a uniform reference, the framework strives to increase stakeholder collaboration by aligning their goals and efforts in creating a healthy office environment.

> **CRE1**: *"For us to achieve all project goals, we also constantly strive at the company to ensure there is regular engagement and interaction with different stakeholders."*

- **Evidence-Based Practices:** The framework will be built on evidence-based techniques, including insights from research and industry standards from experienced professionals, to guarantee that its suggestions are credible and compelling.
- **Scalability and Flexibility:** Designed to be adaptable to various office types and sizes, the framework will be flexible to accommodate varying project scales and configurations, ensuring relevance across multiple settings. This is in response to the challenge of lack of flexibility in the current approach5.5.7

> **SC1**: *"What exactly is required is flexibility in the approach, so the requirements do not exceed the client's vision for the project and we can find a perfect balance in between client requirement and the health and well-being goals set to achieve"*

6.2 Program of Requirements for the Framework

The adapted framework's Program of Requirements (POR) is developed to ensure that the framework effectively solves the problems identified while meeting the specific requirements of Dutch office buildings. This section covers the framework's fundamental needs and functions for improving occupant health and well-being while conforming to local standards and practices.

1. Integration of foundational elements:
    - The framework must include essential factors for occupant health and well-being, such as air quality, thermal comfort, visual comfort, acoustic comfort, water quality, safety, spatial comfort, accessibility, biophilic design, and personal control.
    - Each element must be tailored to the context of Dutch office environments to be relevant and effective.
2. Contextual adaptation: This addresses the challenge of relevance of WELL features in the Dutch Context 5.5.2.
    - The framework should be tailored to the unique needs of Dutch office buildings, including local building laws, standards, and cultural concerns.
    - It must consider the specific requirements of the stakeholders while adhering to the Dutch approach to office design and occupant well-being.
3. Design Considerations For Project Stages:(This is to mitigate the challenge that the current guidelines help set a goal but do not guide through different considerations in project phases 5.5.2)
    - The framework must include specific design considerations at every stage of an office building project, from the project definition phase to the construction and Handover phases
    - It should include specific requirements and considerations for incorporating health and well-being aspects throughout all the design phases
4. Performance indicators and metrics: (This is one of the steps to mitigate the barrier of balancing global and local requirements 5.5.3
    - The framework should specify key performance indicators (KPIs) and metrics for each core element, establishing clear benchmarks for evaluating performance and compliance.
    - The framework must include mandatory indicators for aspects vital to objective health and well-being while allowing for optional indicators that impact health but are not critical, such as biophilic soundscapes.
5. Ease of interpretation and implementation:
    - The framework must be user-friendly so stakeholders can easily interpret and apply it.
6. Bridging the Regulatory and Standards Gap:This addresses the challenge of 5.5.3
    - The framework is intended to bridge the gap between international guidelines like WELL certification and the Dutch Building code.
    - It must facilitate seamless integration by complying with local regulatory needs.
7. Holistic and Comprehensive Approach:
    - The framework must take a holistic approach, considering the interactions of several basic aspects and their cumulative impact on occupant health and well-being.

- It should support a balanced and integrated design strategy that considers all essential areas of office environment quality, resulting in an effective solution.

6.3 Concept of the framework

Concept of the Framework The framework developed in this study is a structured tool that can help integrate health and well-being elements into the design of office building projects. This framework was developed in response to gaps identified in existing international standards, such as WELL when applied to the Dutch context, as well as insights gained from industry expert interviews and content analysis of Dutch regulations. The framework aims to balance global health and well-being principles and local requirements, providing an approach specifically tailored to the Dutch office building environment.

Core principles and adaptation to context:

The framework's fundamental concept is contextual adaptation, which combines the strengths of international standards(WELL) while aligning them with Dutch building codes (BBL) and local practices. The framework addresses Dutch office buildings' unique regulatory, environmental, and cultural requirements by incorporating different foundational elements that influence the design and functioning of a healthy office building 5.2.

An iterative and validated approach

The framework is based on an iterative process that enables the evaluation of well-being strategies at various design stages of the project lifecycle 5.4. Each foundational element and its KPI's has been reviewed and validated by industry experts to ensure that the tool provides evidence-based guidance D. This validation process ensures that the framework meets regulatory requirements and incorporates best practices that have been proven effective in real-world scenarios.

Customization and Flexibility

While the framework firmly adheres to essential KPIs, it also allows for optional well-being enhancements, making it adaptable to the unique needs of each project. While objective ranges of air quality or thermal comfort may be required for regulatory compliance, additional elements, such as a few considerations about placement and frequency of restorative spaces or biophilic design features can be added based on client preferences or budgetary constraints. This adaptable approach ensures that projects can maintain high levels of well-being without burdening stakeholders with unnecessary requirements, to understand what are the optional and mandatory elements refer D.

Integration of Stakeholder Input

One of the framework's distinguishing features is incorporating stakeholder perspectives, both top-down (e.g., project leaders, well-being experts) and bottom-up (e.g., occupant surveys). Including stakeholder feedback ensures that the framework is aligned with the project's well-being goals while accommodating the preferences and needs of the occupants, who will ultimately use the space. This dual perspective contributes to the framework's relevance and effectiveness.

Stage-Specific Design Considerations

The framework includes specific design considerations for each project phase to ensure that well-being is integrated throughout the office building's lifecycle. From project definition to handover, the framework ensures that the project remains on track with the well-being objectives 5.4.

Bridging International Standards with Local Regulations

One of the framework's primary goals is to close the gap between international certification standards like WELL and the Dutch regulatory environment 5.5.3. By combining global best practices with local codes and industry norms, the framework provides a useful tool for ensuring compliance with local(BBL,NVBV, etc) and international standards(WELL). This dual alignment enables the framework to be confidently applied to various office-building projects in the Netherlands, making it an invaluable resource for project teams seeking to create healthier work environments.

6.4 Elements of the framework

The framework developed in this study is based on a set of fundamental elements critical for ensuring office occupants' health and well-being. These components as mentioned in 5.2 were carefully chosen and validated using a combination of expert interviews, content analysis of international standards like WELL, and a thorough review of Dutch regulatory requirements. Each element contributes significantly to the indoor environment, influencing the occupants' physical, mental, and emotional well-being.

At its core, the framework addresses fundamental elements influencing indoor environmental quality in an office building. These components include air quality, thermal comfort, visual comfort, acoustic comfort, water quality, biophilic design, personal control, safety, spatial comfort, and accessibility. Research has identified these factors as having a significant impact on occupant well-being, and they serve as the foundation elements. The framework also incorporates design considerations for these fundamental elements across the various project phases. From Project Definition to Handover, the framework provides specific guidelines for incorporating selected KPIs as shown in the appendixD of these elements at each stage, ensuring that well-being is always prioritized. By incorporating phase-specific design strategies, the framework ensures an integrated approach to achieving health and well-being objectives throughout the design stages of the projects as mentioned in 5.4.

1. **Project Definition and Stakeholder Alignment**
   - Establishing project-specific well-being goals.
   - Gathering input from stakeholders (HR, Corporate Real Estate, Sustainability teams).
   - Conducting occupant feedback surveys to integrate end-user preferences.
2. **Brief Preparation and KPI Selection**
   - Selecting Key Performance Indicators (KPIs) to meet well-being goals.
   - Forming a Program of Requirements.
   - Distinguishing between mandatory and optional elements.
3. **Schematic Design Phase**
   - Broad conceptualization of well-being elements (air quality, thermal comfort, visual comfort).
   - Initial zoning and spatial layout considerations.
4. **Concept Design Phase**
   - Refining the well-being goals into detailed design plans.
   - Determining technical capacities for systems like air handling, lighting, and biophilic elements.
5. **Detail Design Phase**
   - Selection of materials, finishes, and technical systems that align with well-being goals.
   - Defining installation specifications (e.g., air quality sensors, acoustic solutions).
6. **Technical Design Phase**
   - Finalizing all technical and design specifications.
   - Ensuring alignment with well-being objectives in preparation for construction.
7. **Construction Phase**
   - Overseeing the implementation of health and well-being strategies during construction.
   - Monitoring alignment between physical construction and well-being goals.
8. **Handover Phase**
   - Validating that the KPIs set during the Brief Preparation phase are achieved.
   - Monitoring and testing building performance for health and well-being.
9. **Monitoring and Feedback Mechanism**
   - Spider diagram showing the progress of well-being targets.
   - Retrospective check to ensure all necessary design considerations have been addressed.
10. **Flexibility and Iterative Process**
    - Option to adapt KPIs and well-being elements based on project-specific needs.
    - Ability to revisit earlier phases and adjust decisions as needed.

6.4.1. Use of the Framework

The suggested framework is an interactive tool that will help project teams or well-being professionals navigate the structured process of integrating health and well-being elements into the design of office building projects. It takes a step-by-step approach, ensuring that well-being concerns are addressed at each stage of the project lifecycle while allowing for flexibility and adaptability in response to individual project needs and stakeholder preferences.

The initial step in using the framework is to either create a new project or access an existing one. The Project Definition phase is crucial for coordinating well-being definitions among all stakeholders. Here, the key user—typically a well-being expert or a project team member—must consolidate

a unified well-being definition by incorporating input from diverse stakeholders, ensuring that all perspectives are considered. In addition, an occupant feedback form is supplied, allowing the client to receive insights directly from end users (occupants), whose preferences and demands are critical in determining project goals.

During the Brief Preparation phase, the emphasis moves to identifying key performance indicators (KPIs) aligned with the established well-being goals. The user is guided through creating a Program of Requirements that describes the project's unique well-being objectives. This phase is essential for establishing clear and quantifiable goals that will be monitored throughout the design and construction process.The framework then moves on to the Schematic Design phase, when design considerations for each core well-being factor (air quality, thermal comfort, and visual comfort) are presented. These principles are applied to each following phase, including Concept Design, Detail Design, and Technical Design. At each level, the tool gives focused design options that must be considered to guarantee that the well-being goals established in prior phases are effectively incorporated.

Once the project enters the Construction and Handover phases, the framework prompts the user to review the KPIs set during the Brief Preparation phase. The user is responsible for determining if the aims have been reached, ensuring that the completed building aligns with the well-being objectives established at the start of the project. The framework also contains a spider diagram, which visually depicts the project's progress, demonstrating the degree of goal selection and its ability to accomplish its set objectives. This tool helps customers to track project progress and alter their methods as needed.

The framework provides the option to transition between phases, allowing users to return to prior stages to confirm that all relevant concerns have been handled or to proceed to the next step for planning. This flexibility promotes ongoing alignment with project objectives, allowing for more effective decision-making and planning. The framework also distinguishes between mandatory and optional parts, allowing the project's approach to be tailored based on budget limits, specific well-being priorities, or stakeholder preferences. This framework serves as both a guide during each step of the project and a flexible instrument that can meet the particular requirements of various office projects. It allows project teams to ensure that well-being elements are properly integrated, monitored, and realized throughout the design and construction process, resulting in healthier office environments.

6.4.2. Mandatory and Optional Aspects of the framework

The decision to designate some aspects as mandatory while others are optional within the framework is grounded in the distinction between objective health requirements and subjective well-being enhancements. Mandatory aspects include key performance indicators (KPIs) such as air quality (e.g., CO_2 levels), thermal comfort, and visual comfort, which are tied to strict, measurable ranges critical to ensuring occupants' basic health and safety. These objective indicators, often governed by regulations or strict health guidelines, are essential for maintaining a baseline level of well-being and are thus non-negotiable. On the other hand, optional aspects cover more subjective elements, such as certain aspects of biophilia and spatial comfort, which, while beneficial, can be adapted to specific project needs and preferences. These aspects enhance occupant satisfaction and well-being but are not strictly necessary for meeting fundamental health requirements. For example, elements like the

presence of plants, green walls, or specific restorative spaces provide flexibility for the project team to tailor the environment based on available resources, client preferences, and the specific context of the building.

Additionally, the framework includes some requirements that allow for flexible choices, such as selecting one or more from a set of options. This flexibility allows stakeholders to prioritize based on the project's goals while still adhering to overall well-being objectives. For example, design elements may offer the choice between natural soundscapes or acoustic treatments, enabling customization to meet the space's and its occupants' unique needs. The distinction between mandatory and optional aspects ensures that essential health and safety standards are met while allowing for adaptability in elements that enhance occupant comfort and well-being. This approach balances compliance and flexibility, catering to regulatory requirements and project-specific well-being goals.

6.5 Proposed Framework

The proposed framework addresses identified gaps and challenges while incorporating stakeholder insights and practical considerations. It includes the following:

- **Comprehensive Elements**: A detailed list of elements that define a healthy office building.
- **KPIs and Indicators**: Specific KPIs for each element to measure performance.
- **Implementation Steps**: Clear, actionable steps for integrating well-being into each project lifecycle stage.
- **Validation and Monitoring**: Procedures for regular assessment and feedback to ensure ongoing alignment with well-being goals.

By developing this integrated approach, the framework aims to facilitate the creation of healthier office environments that enhance both occupant satisfaction and productivity, tailored specifically to the needs of Dutch office buildings. A few snippets of a developed prototype is as follows:

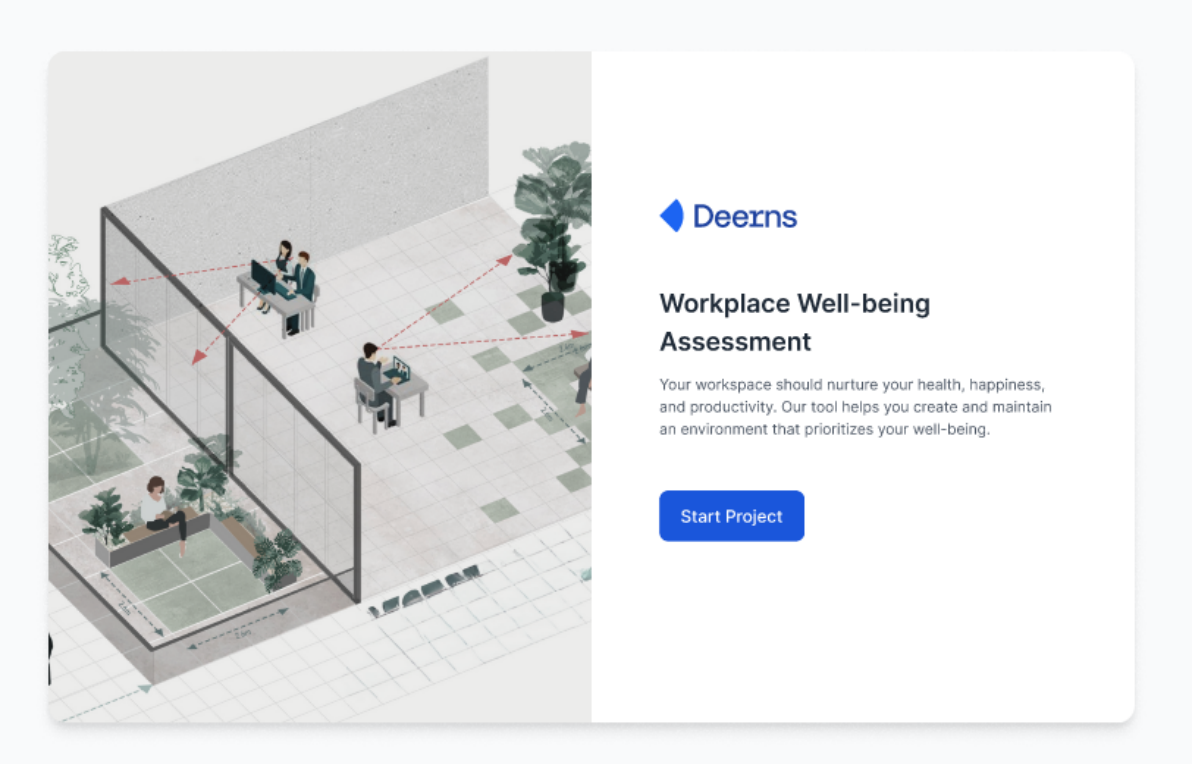


Figure 6.1: Interface of the framework-1

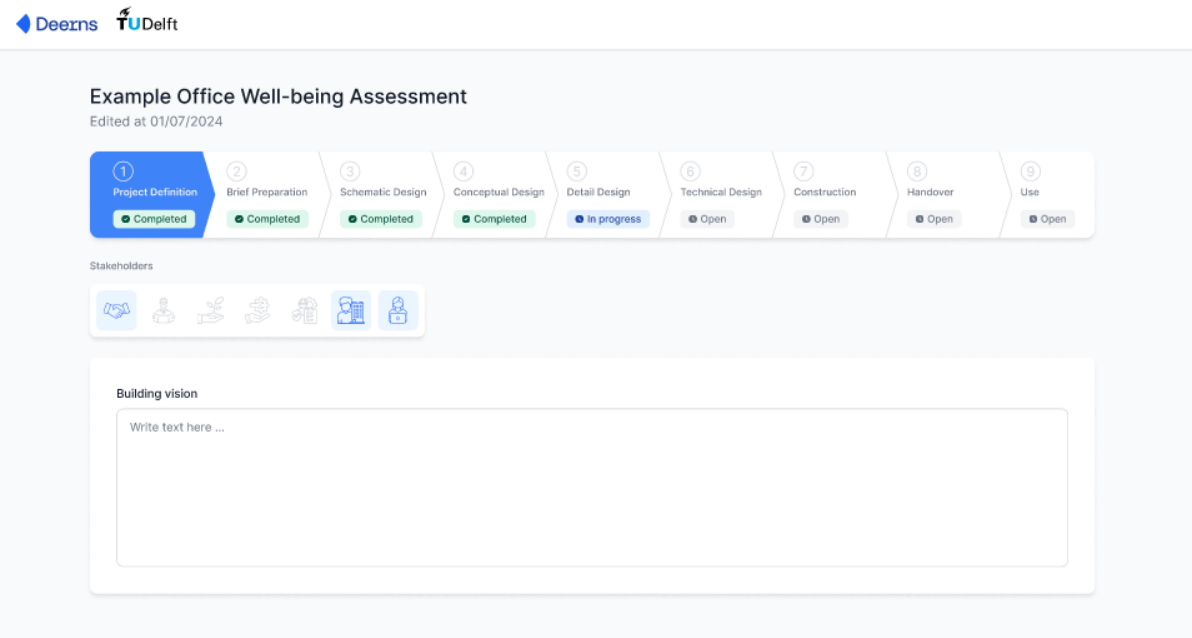


Figure 6.2: Interface of the framework-2

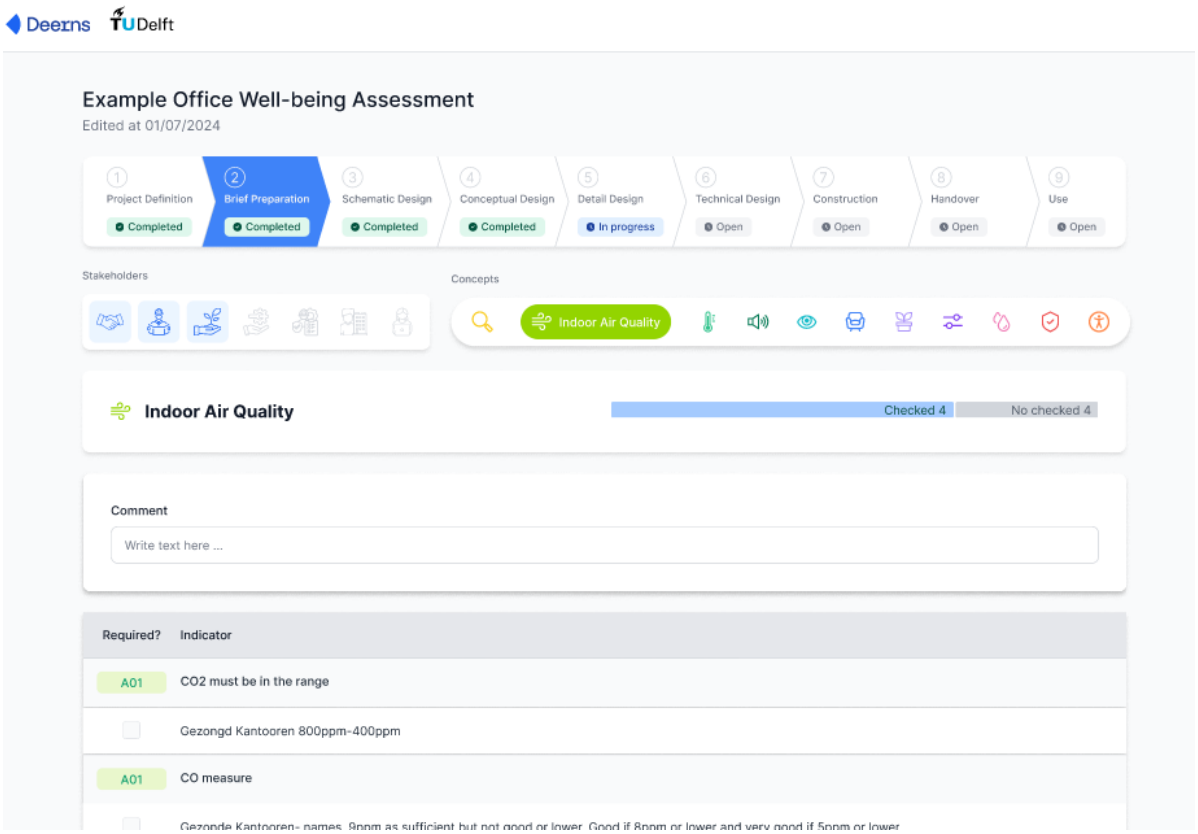


Figure 6.3: Interface of the framework-3

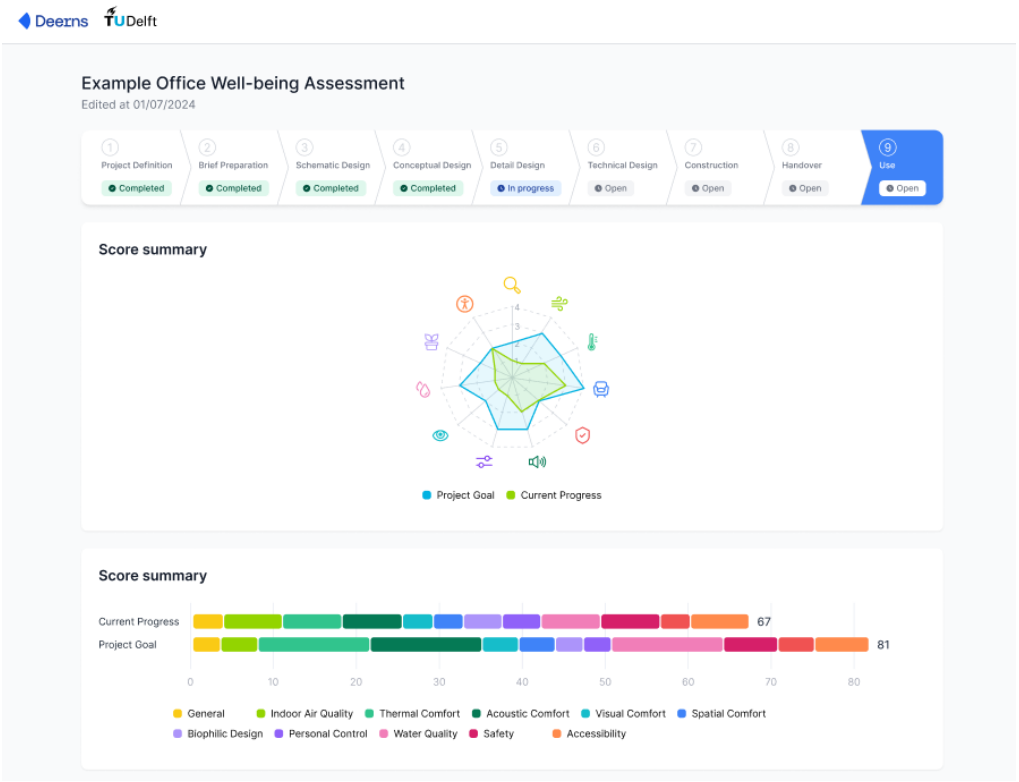


Figure 6.4: Interface of the framework-4

7

Discussions

This study intended to develop healthier office environments that address the health and well-being of occupants, adapted specifically to the Dutch context. The findings of this study indicate that while existing methods largely involve attaining WELL certification, which offers a framework for promoting health and well-being in workplace environments, their implementation in the Dutch context requires careful consideration and adaption. The research problem revolved around tailoring these global standards to Dutch office buildings' unique regulatory, environmental, and cultural requirements. Expert interviews and content analysis identified that, while many of WELL's KPIs are helpful, some require supplementation or adaptation with local requirements to be effective in the Dutch environment. One of the interviewees pointed out the lack of a unified well-being strategy that could be consistently applied across a company's various global branches, citing differences in approach between locations such as the Netherlands and China [CRE1]. While the idea of a common strategy might appear beneficial, the research findings suggest that such an approach would fail to address the specific needs of each context. This underscores the necessity for a tailored strategy that adapts to each office location's unique environmental, regulatory, and cultural conditions, ensuring that well-being initiatives are truly effective and contextually relevant.

The comparative analysis between the WELL Building Standard and the Dutch Building Code (BBL) showed critical differences in their approach to occupant health and well-being. While WELL offers comprehensive health performance indicators, many of these indicators do not fully align with the Dutch regulatory framework or local environmental conditions and the Dutch building code had set requirements but as mentioned 5 were considered bare minimum and not enough to attain healthy comfort levels in an office building. Expert interviews highlighted that several recommendations in the WELL guideline require stricter or different thresholds or levels in the Dutch context to achieve optimal health outcomes. As a result, a tailored list of Key Performance Indicators (KPIs) was developed, incorporating expert recommendations to suit Dutch office environments better, as shown in D. The study also emphasizes the importance of defining well-being goals early in the

project lifecycle, acknowledging the subjective nature of the concept—a perspective echoed in the literature and interviews, highlighting the variability in stakeholder perceptions of health and well-being (Christoforou et al., 2024).

7.0.1. Use of the framework and advantages

One of the framework's strengths is its flexibility, which allows project teams to choose relevant Key Performance Indicators (KPIs) based on their project's objectives and priorities. This adaptability allows the framework to be tailored to various project contexts while strongly emphasising increasing occupant health and well-being. However, the framework's mandatory requirements balance out this freedom. These non-negotiable aspects are intended to address the objective aspects of a healthy building design to ensure that all projects meet a minimal standard of health and well-being, so establishing a consistent foundation for better working environments.
In light of that, the research distinguishes between objective and subjective well-being elements. Objective KPIs—such as air quality and thermal comfort—are critical for occupant health and were classified as mandatory. At the same time, subjective elements, like a few aspects of biophilic design, were deemed optional, allowing for flexibility based on project-specific needs and preferences. This distinction ensures that essential health requirements are met while providing flexibility and adaptability in areas that enhance occupant satisfaction. Industry well-being experts additionally validated the final KPIs and assigned the mandatory and optional aspects in the requirement.

Additionally, the framework is tailored to comply with the Dutch Building Code (BBL) and is specifically developed to meet the unique environmental, cultural, and regulatory demands of Dutch office buildings. This connection with local regulations simplifies legal compliance and increases the framework's relevance and usefulness in the Dutch context. This approach allows companies to focus on the most important health and well-being objectives without getting bogged down by administrative formalities. This focused approach results in a more efficient allocation of resources, allowing teams to meet high standards of occupant health and well-being while adhering to Dutch regulations. The framework enables companies to fulfil their well-being goals more efficiently and affordably while avoiding the enormous administrative burden of conventional certification methods.

In practical terms, the framework is a complete guide through the many stages of an office building project design. It enables stakeholders to incorporate design considerations addressing the health and well-being of occupants into all stages of the design process, from early planning to construction and handover. In addition, the framework encourages regular evaluation, allowing teams to revisit earlier stages to confirm that all considerations have been satisfied and to plan for future activities. This organized approach improves the project's thoroughness and efficiency and assures that the office space is optimally designed to support occupant well-being.

7.0.2. Practical Implementation and Implications

The suggested framework's practical application provides a strong approach to improving health and well-being in Dutch office buildings while aligning with local regulations and international best practices. This framework allows for the seamless integration of health and well-being goals across the design stages of an office building project in the Netherlands. This ensures that these considerations are incorporated into each phase, from project definition and brief preparation to construction and handover.

The findings highlight that while awareness of health and well-being in office design is high, practical tools for integrating these strategies still need to be completed. Although WELL is widely referenced, companies struggle with its complexity, and administrative burden and applicability challenges in the Dutch context. By focusing on the special needs of the Dutch context, the framework tackles the research's distinctive challenges, specifically the necessity for a tailored strategy that considers legislative requirements, cultural preferences and stakeholder perspectives. Stakeholder insights reveal a growing awareness of the long-term benefits of investing in healthier office environments. Corporate real estate representatives and well-being consultants emphasized that healthier workplaces increase productivity, reduce absenteeism, and improve employee satisfaction. An early definition of well-being goals and an informed selection of KPIs enable clients to make targeted investments that enhance occupant well-being and organizational performance.

The implications of implementing this framework are significant since it helps create healthier workplace settings and adds to a more consistent approach to well-being in the building design process. This framework can be used as a reference model for future projects, encouraging uniformity in the implementation of health and well-being initiatives across the design of several office buildings, thereby building on the degree of awareness occupants and other stakeholders of the impact of a healthy office environment It also helps project teams measure and evaluate the success of their designs, ensuring that they achieve the desired health and well-being results. The practical implementation of the proposed framework finds strong support in one of the consistent themes that emerged from the stakeholder interviews: the collective drive among project teams to create office spaces that employees are eager to return to (FM1, CRE1, SC1, AR2, C1). The proposed framework supports this goal by including health and well-being considerations into every stage of the office design process; by ensuring that spaces are optimised for comfort, safety and environmental quality, the framework sims to create office environments that make employees want to return to.

The framework's emphasis on context-specific KPIs and design considerations ensures that the office spaces created are compliant and optimized for occupant satisfaction and productivity, which have many more long-term benefits (Appel-Meulenbroek et al., 2021). This strategic connection with the Dutch context emphasizes the framework's potential as a useful tool for enhancing office settings, with significant implications for occupant well-being and office-building projects' long-term viability. By incorporating these findings into the framework, the study adds to a better knowledge of designing and executing healthier office settings in the Dutch context.

7.0.3. Applicability and Potential Consequences of Non-Adoption

The suggested framework is especially applicable to the design of new office buildings in the Netherlands, where it can serve as a guide to ensure that health and well-being objectives are systematically integrated throughout the design stages of a project. While the framework may not fully address the intricacies of existing buildings, it can nonetheless contribute by assisting in developing or refining health and well-being initiatives during renovations to improve indoor environmental quality. The framework's emphasis on tailored selection of KPIs ensures that only the most relevant and impactful elements are addressed, narrowing the focus to areas that have a direct impact on occupant well-being in office spaces.
Without introducing such a framework, project teams and experts will continue to grapple with the complex task of navigating multiple guidelines—such as the Dutch building code and WELL standards—each time a new project begins. This piecemeal approach not only takes a long time initially but also increases the possibility of misalignment among stakeholders, making it difficult to build a cohesive project brief. It also exposes project teams to the administrative burdens of evaluating and integrating various guidelines separately. This may slow decision-making and increase the likelihood of overlooking critical design considerations during the transition between project phases. The suggested framework empowers project teams by providing a structured approach to developing healthy workplace environments adapted to the Dutch setting.

7.0.4. Theoretical contributions

The theoretical contribution of this study is creating a tailored framework designed to improve the health and well-being of indoor office environments in the Dutch context. This study provides a structured approach to creating healthier office buildings that are contextually appropriate and tailored to the specific needs of the Netherlands by incorporating insights from global standards such as the WELL Building Standard and aligning them with the requirements required to achieve optimal levels of health and well-being in Dutch office buildings. It acknowledges that, while the WELL standard is broad, its complete application in the Dutch environment is not necessarily optimum, and the Dutch building code merely specifies the bare minimum standards (CRE1, LD1, LD2. SWBC1, MEP1)

This study contributes to the academic understanding of how health and well-being factors can be systematically integrated into design and construction processes flexibly and context-appropriately. The study is especially significant to the Dutch construction industry since it provides a structured but adaptable approach to improving occupant health and well-being in office environments. This study thus not only contributes to academic research but provides practical suggestions that can be implemented in the field, improving both theory and practice in the design of healthy office buildings.

7.0.5. Limitations of the study

Acknowledging its inherent limitations is one of the most essential aspects of carrying out research. While this study has made progress in addressing the gaps in building healthier workplace settings in the Dutch context, certain limitations must be acknowledged to provide a balanced understanding of the research findings. The results' generalizability is limited due to its focus on Dutch office buildings. While the framework was created to fulfil the context of the Netherlands, it may not fully apply to office environments in other locations with differing regulations, cultural expectations, or environmental conditions. Furthermore, using stakeholder interviews as data sources involves subjectivity in the findings, as the perspectives and experiences of the selected participants influence them. However, the study included different stakeholder perspectives due to the time constraints of the limited number of each of the stakeholders involved in the process of designing a healthy office building were limited.

Another limitation is the study's scope, which focuses exclusively on new office construction projects. Although the framework can give useful insights for upgrading current buildings, its application to retrofitting older structures or other building types is outside the scope of this study. Furthermore, the study was limited because it focused primarily on design issues throughout the design stages of a healthy office building project, and it did not address the operational or post-occupancy stages. Furthermore, the study focuses primarily on how the built environment affects mental well-being, ignoring broader HR practices commonly utilized to improve mental health in the workplace. This constraint restricts the scope to architectural and environmental aspects in office design rather than investigating the whole range of well-being methods, such as organizational policies or staff engagement programs.

Furthermore, the study is limited to indoor office environments, eliminating outdoor spaces, as they are limited in office buildings and work is predominantly indoor desk work. This focus narrows the findings' general relevance to the entire range of surroundings that contribute to a complete workplace experience. The study's approach was limited by accessible data and time constraints, which may have influenced the depth of investigation in some areas. Despite these limitations, the findings are relevant for answering the research question and contributing to discussing healthy office environments.

8

Conclusion

As awareness and demand for healthy office environments rise, it becomes obvious that while good, established frameworks such as the WELL Building Standard may not fully address the unique needs of the Dutch office context. The primary goal of this study was to address the challenges posed by this misalignment and provide a tailored approach that combines best practices from global well-being standards with the specific requirements of Dutch office buildings. This study emphasized the importance of designing indoor office environments that meet regulatory requirements and go above to create surroundings that actively improve occupant well-being and productivity. The findings indicate that while the WELL Building Standard provides a strong framework, its implementation in the Netherlands requires careful adaptation to account for local legal, cultural, and environmental variables. This adaptation is required to ensure that health and well-being objectives are satisfied and in line with the unique expectations and problems of Dutch office buildings.

This study suggests an alternative structure specific to the Dutch situation to bridge the gap between global well-being standards presented through WELL certification guidelines and local demands. This framework addresses the shortcomings of existing standards by offering a systematic, context-specific approach that incorporates practical design considerations throughout the design stages of an office building project, from project definition and brief preparation to construction and handover phases. It allows for the selection of Key Performance Indicators (KPIs) based on project demands while maintaining mandatory regulations that promote the design of healthier indoor office environments.

If this framework is not implemented, project teams and consultants may experience challenges aligning stakeholder goals and achieving a shared vision for health and well-being. This could result in inefficiencies, higher administrative responsibilities, and the risk of producing office spaces that do not adequately support occupant well-being. As a result, applying this framework is critical for the future of office building design in the Netherlands, guaranteeing that new buildings satisfy regulatory criteria and significantly improve the health and productivity of their occupants.

This study adds to the expanding body of knowledge on healthy office building design by providing a practical, adaptable framework that addresses the unique needs of Dutch office environments. It encourages continued refining and testing of the framework in real-world projects to validate its effectiveness and future study into its applicability in other contexts or expansion to encompass operational and post-occupancy stages. This study proposes a change in how well-being is integrated into office design, encouraging regulatory bodies and industry players to explore adopting and developing such personalized frameworks to promote healthier, more productive workplaces.

8.1 Answering the Research Questions

This study aimed to explore incorporating well-being into the design of office buildings, particularly in the context of Dutch office environments. Below is a summary of how the research addresses each sub-research question and, finally, the main research question.

- **1. What is a healthy office building, and what does it consist of?**
  This question serves as the study's foundation, focusing on the key components that define a healthy office building. The study conducted an extensive literature review to identify critical elements that contribute to occupant health and well-being, such as air quality, thermal comfort, lighting, etc. However, this study expanded on previous definitions by incorporating practical insights from stakeholders in the Dutch Architecture, Engineering, and Construction (AEC) industry. As mentioned in 4 interviews revealed that, while these elements are universally accepted, their prioritization varies according to the project context and stakeholders' goals, making the definition of a healthy office building inherently subjective. As a result, the final framework incorporates these fundamental components while allowing for flexibility based on the specific project requirements.
- **2. What are the current practices related to healthy office buildings in the Netherlands?**
  This sub-question was addressed using both a literature review and stakeholder interviews. The literature revealed that, while frameworks like WELL and BREEAM-NL are frequently mentioned, their practical application varies between projects. As mentioned in 5, interviews revealed additional details about how industry professionals selectively apply these standards. Depending on the project's objectives and constraints, only a subset of these certifications are frequently implemented. This selective application reflects a growing trend in which stakeholders strike a balance between global certifications and local regulations, such as the Dutch Building Code (BBL), in order to achieve well-being goals.
- **3. What are the challenges in integrating health and well-being strategies in new office buildings?**
  As mentioned in 5.5, Semi-structured interviews with stakeholders involved in office building projects were the primary means of identifying challenges. Common concerns included regulatory misalignment between WELL and Dutch building codes, administrative burdens, the challenge of balancing well-being goals with other design objectives and lack of a process based approach. The study found that, while WELL is a comprehensive guideline, it does not always fully align with local Dutch conditions. These challenges highlighted the need for

a more tailored approach that addresses the unique needs of the Dutch context while incorporating best practices from international standards that guides through the different design stages of the office building project.

- **4.How and what kind of approach can assist in addressing these issues?**
  To address the identified challenges, the research formulated a customized framework that bridges the gap between global standards and Dutch regulations. The comparison of WELL, BREEAM-NL, and the Dutch Building Code revealed gaps where international standards did not fully meet the local context. The study defined optimal levels for KPIs and integrated them into the framework after a content analysis of local building code, international standards such as WELL and also guidelines like NVBV, Gezonde Kantooren etc suggested by experts during interviews, a compiled list of which is mentioned in the D. The framework also mentions considerations at each project stage to facilitate meeting aimed KPI levels to ensure the most occupant comfort in indoor office environments. The proposed approach not only ensures compliance with local regulations, but it also incorporates best practices from existing frameworks, resulting in a more practical, context-specific solution for designing healthier offices.

Main Research Question: How can well-being be effectively included in the design and construction of office buildings to improve indoor environmental quality and occupant satisfaction?

The personalized framework established in this study efficiently addresses the main research question by giving an organized way to incorporate well-being into the design and construction of office buildings. The framework includes all the foundational aspects that influence occupant health and well-being, as well as KPIs and ideal levels tailored to Dutch office environments. The framework helps project teams and consultants create healthier workplace spaces by articulating design considerations for each project step. This approach ensures that well-being is considered from the beginning of design, allowing for the creation of indoor environments that improve occupant comfort and well-being.

However, the study recognizes that there is no one-size-fits-all answer. The ”healthiest” office building concept is fundamentally subjective, with each project presenting its challenges and requirements. As a result, the framework provides a flexible yet comprehensive tool that can be applied to various projects, allowing stakeholders to design office settings that fulfil both objective health criteria and occupants' demands. This personalized method provides a practical answer for efficiently incorporating well-being into office building design, resulting in settings that enhance health, comfort, and productivity.

8.2 Recommendations for the Company Deerns Nederland BV

The following recommendations are intended to help Deerns Nederland BV effectively integrate the findings of this research into their consultancy practices, thereby improving their ability to guide clients in designing healthier office environments:

Improved Client Consultation on Health-Centred Design Based on the research findings, Deerns could provide detailed consultation services emphasizing the importance of establishing well-being goals from the start of a project. This includes informing clients about how a tailored framework (rather than relying solely on certifications such as WELL) can provide a more flexible and project-specific approach to meeting occupant well-being goals. This consultation should include clear guidance on selecting the appropriate KPIs based on the project's specific needs and client preferences.

Stakeholder Alignment and Early Engagement. The study emphasizes the importance of aligning stakeholder perspectives early in the project lifecycle to ensure that well-being objectives are consistent and attainable. Deerns should create a more structured process for gathering feedback from various stakeholders, such as HR, facility managers, and end users. Throughout the design and construction phases, regular workshops and feedback loops should be implemented to ensure that project goals are consistently aligned with stakeholder and occupant needs.

Tailored Application of the Developed Framework To speed up the integration of the tailored framework, Deerns should adopt and customize it for use in their project management tools. This includes providing clients with a clear process for incorporating well-being considerations throughout all project phases—from project definition to post-occupancy monitoring. Deerns can use this tool to guide clients through the complexities of selecting relevant KPIs, implementing design considerations, and ensuring compliance with both the Dutch Building Code and international standards such as WELL.

Client Support for Mandatory and Optional KPIs Deerns should create support systems to help clients distinguish between mandatory health-related KPIs (such as air quality and thermal comfort) and optional well-being enhancements (for example, biophilic design). This will enable clients to make informed decisions about where to prioritize investment based on budget and project objectives, while also ensuring that mandatory elements are met to achieve a baseline level of occupant well-being.

Guided Project Phase Considerations: Using research findings on project phase-specific design considerations, Deerns should provide detailed roadmaps that guide clients through each project phase—Project Definition, Schematic Design, Detail Design, and Construction. This would ensure that critical well-being elements are integrated in a systematic manner, with clear milestones and validation points to monitor progress against established KPIs.

Ongoing Monitoring and Feedback Mechanisms The study emphasizes the importance of continuously assessing well-being throughout the project's lifecycle. Deerns should provide clients with post-occupancy evaluation tools, such as real-time dashboards or regular well-being audits, to ensure that indoor environmental quality metrics (such as air quality, acoustics, and lighting) are met. These tools will assist clients in continuously improving the well-being of occupants using data-driven insights.

Training and Knowledge Transfer Based on Research Findings To effectively implement the research findings, Deerns should invest in training their teams on the key insights and methodologies outlined in the tailored framework. This training should help consultants apply the framework's principles in a practical setting, ensuring they are well-equipped to effectively guide clients through health-centric design decisions.

Tailored Solutions for the Dutch Office Building Context As the research revealed the need for

a more context-specific approach, Deerns should concentrate on providing tailored solutions that meet the specific requirements of Dutch office environments. This includes adapting international certifications to the local context, ensuring that well-being strategies are compliant with Dutch building codes, and incorporating stakeholder feedback and cultural norms.

These recommendations are based on research findings and aim to provide Deerns with actionable steps to improve the practical implementation of healthier office building designs. By aligning their consulting practices with these insights, Deerns can provide clients with a more tailored, effective, and research-backed approach to achieving occupant well-being in office settings.

8.3 Recommendations for future research

The following recommendations are intended to direct future research into establishing more effective, adaptive, and impactful solutions for encouraging healthier workplace settings, building on the foundations built by the current study.

- Longitudinal studies on occupational well-being: Conduct long-term research to track the impact of various well-being techniques on employee health and productivity over time, providing evidence for continual improvement in office design.
- Cost-Benefit Analysis of Tailored Frameworks: Investigate the economic consequences of using a tailored well-being framework rather than traditional certification methods, to assist firms in understanding the financial benefits of customized approaches.
- Cross-Disciplinary Approaches: Encourage research that combines concepts from architecture, psychology, environmental science, and public health to gain a more comprehensive knowledge of what makes up a healthy workplace environment.
- Sustainability and Well-Being Synergy: Look at how sustainability and well-being goals might be aligned in office building projects and discover techniques that maximize both environmental and human health benefits.
- Behavioral Analysis in Office Environments: Investigate the behavioural characteristics of how employees interact with their workplace, focusing on how these interactions influence the effectiveness of well-being initiatives.
- Scalability of Well-Being Frameworks: Investigate the scalability of well-being frameworks for all sorts of businesses, ranging from giant corporations to small and medium-sized enterprises, to ensure that approaches are flexible and practicable across settings.
- Policy Implications of Healthy Office Designs: Examine the larger policy implications of incorporating health-centric design concepts into office buildings, including potential effects on urban planning and public health policy.
- Global Adaptability Studies: Investigate how well-being frameworks designed for the Dutch environment can be applied to other regions with similar or dissimilar climates, legislation, and cultural backgrounds.

References

THE 17 GOALS | Sustainable Development. (n.d.). Retrieved from https://sdgs.un.org/goals

2030, B., & BPIE. (2018). *Building 4 People: Building the business case for better office, school and hospital buildings in Europe* (Tech. Rep.). Retrieved from https://www.bpie.eu/wp-content/uploads/2018/12/market_paper_031218.pdf

Allen, J. G., G., HEALTH, F., of Public Health, H. T. C. S., Bernstein, A., Cao, X., Eitland, E. S., ... Yin, J. (2017). *THE 9 FOUNDATIONS OF a HEALTHY BUILDING.* Retrieved from https://9foundations.forhealth.org/wp-content/uploads/2020/02/9_Foundations_of_a_Healthy_Building_February_2017_R1.8.pdf

Alvarsson, J. J., Wiens, S., & Nilsson, M. E. (2010, 3). Stress Recovery during Exposure to Nature Sound and Environmental Noise. *International Journal of Environmental Research and Public Health*, *7*(3), 1036–1046. Retrieved from https://doi.org/10.3390/ijerph7031036 doi: 10.3390/ijerph7031036

AnniWeiler. (2004). *Working time in europe | european foundation for the improvement of living and working conditions.* Retrieved from https://www.eurofound.europa.eu/en/resources/article/2004/working-time-europe

Anumba, C. J., Kamara, J. M., & Cutting-Decelle, A.-F. (2006). *Concurrent engineering in construction projects*. Retrieved from https://doi.org/10.4324/9780203968918 doi: 10.4324/9780203968918

Appel-Meulenbroek, R., Arentze, T., Kemperman, A., Buskermolen, W., & Van Den Putten, V. (2021, 1). Willingness to pay for healthy office workplace aspects - preferences of workplace decision makers. *28th Annual European Real Estate Society Conference*. Retrieved from https://doi.org/10.15396/eres2021_12 doi: 10.15396/eres2021\{_}12

Barclay, C., Project, Q. R. G., & of Sociology, H. U. D. (2018, 3). *Semi-Structured interviews* (Tech. Rep.). Retrieved from http://www.qualres.org/HomeSemi-3629.html

Barton, H., Thompson, S., Burgess, S., & Grant, M. (2015). *The Routledge Handbook of Planning for Health and Well-Being*. Retrieved from https://doi.org/10.4324/9781315728261 doi: 10.4324/9781315728261

Becker, F., & Steele, F. (1995). *Workplace by design: Mapping the high-performance workscape*. Wiley. Retrieved from https://books.google.nl/books?id=0WJPAAAAMAAJ

Berquand, C., Barthelmes, V. M., Spigliantini, G., Vergerio, G., Becchio, C., Corgnati, S. P., & Khovalyg, D. (2022, 5). Review of health and well-being aspects in Green Certification Protocols. *proceedings.open.tudelft.nl*. Retrieved from https://doi.org/10.34641/

clima.2022.322 doi: 10.34641/clima.2022.322

Bhandari, P. (2020) What is Qualitative Research Methods. (2020). Retrieved from https://www.scirp.org/reference/referencespapers?referenceid=3087568

Bluyssen, P. M., Janssen, S., Van Den Brink, L. H., & De Kluizenaar, Y. (2011, 12). Assessment of wellbeing in an indoor office environment. *Building and Environment*, *46*(12), 2632–2640. Retrieved from https://doi.org/10.1016/j.buildenv.2011.06.026 doi: 10.1016/j.buildenv.2011.06.026

Boyce, P., Hunter, C., & Howlett, O. (2003). *The Benefits of Daylight through Windows.* Retrieved from https://www.semanticscholar.org/paper/The-Benefits-of-Daylight-through-Windows-Boyce-Hunter/99e627e7725f4ffd58792d8ee7a1687dd731ab3c

Brager, G. S., Paliaga, G., De Dear, R., & Humphreys, M. (2004, 1). Operable windows, personal control, and occupant comfort. *ResearchGate*. Retrieved from https://www.researchgate.net/publication/280014860_Operable_windows_personal_control_and_occupant_comfort

Bringslimark, T., Hartig, T., & Patil, G. G. (2009, 12). The psychological benefits of indoor plants: A critical review of the experimental literature. *Journal of Environmental Psychology*, *29*(4), 422–433. Retrieved from https://doi.org/10.1016/j.jenvp.2009.05.001 doi: 10.1016/j.jenvp.2009.05.001

Christoforou, R., Lange, S., & Schweiker, M. (2024, 5). Individual differences in the definitions of health and well-being and the underlying promotional effect of the built environment. *Journal of Building Engineering*, *84*, 108560. Retrieved from https://doi.org/10.1016/j.jobe.2024.108560 doi: 10.1016/j.jobe.2024.108560

Colenberg, S., & Jylhä, T. (2021, 11). Identifying interior design strategies for healthy workplaces – a literature review. *Journal of Corporate Real Estate*, *24*(3), 173–189. Retrieved from https://doi.org/10.1108/jcre-12-2020-0068 doi: 10.1108/jcre-12-2020-0068

Council, U. G. (2022, 11). *Urban Green Live Episode 16: What's Next for Healthy Buildings (w/Joe Allen).* Retrieved from https://www.youtube.com/watch?v=nn4DQeBvfeU

De Croon, E., Sluiter, J., Kuijer, P. P., & Frings-Dresen, M. (2005, 2). The effect of office concepts on worker health and performance: a systematic review of the literature. *Ergonomics*, *48*(2), 119–134. Retrieved from https://doi.org/10.1080/00140130512331319409 doi: 10.1080/00140130512331319409

Duffy, F., Jaunzens, D., Laing, A., & Willis, S. (2003). *New environments for working*. Retrieved from https://doi.org/10.4324/9780203223109 doi: 10.4324/9780203223109

Emmitt, S. (2022, 1). Building health and wellbeing. *Building Research Information*, *50*(1-2), 1–5. Retrieved from https://doi.org/10.1080/09613218.2021.2015273 doi: 10.1080/09613218.2021.2015273

Ferreira, M. (2024, 7). *WELL or Fitwel? Getting to know healthy building certification systems.* Retrieved from https://www.gresb.com/nl-en/well-or-fitwel-getting-to-know-healthy-building-certification-systems/

Gheyle, N., & Jacobs, T. (2017). *Content Analysis : a short overview.* Retrieved from http://hdl.handle.net/1854/LU-8543687

Gozalo, G. R., Morillas, J. M. B., González, D. M., & Moraga, P. A. (2018, 5). Relationships among satisfaction, noise perception, and use of urban green spaces. *The Science of The Total Environment*, *624*, 438–450. Retrieved from https://doi.org/10.1016/j.scitotenv.2017.12.148 doi: 10.1016/j.scitotenv.2017.12.148

Guest, G., MacQueen, K., & Namey, E. (2012). *Applied Thematic Analysis*. Retrieved from https://doi.org/10.4135/9781483384436 doi: 10.4135/9781483384436

Heerwagen, J. H., & Orians, G. H. (1986, 9). Adaptations to windowlessness. *Environment and Behavior*, *18*(5), 623–639. Retrieved from https://doi.org/10.1177/0013916586185003 doi: 10.1177/0013916586185003

Heidari, L., Younger, M., Chandler, G., Gooch, J., & Schramm, P. (2016, 11). Integrating health into buildings of the future. *Journal of Solar Energy Engineering*, *139*(1). Retrieved from https://doi.org/10.1115/1.4035061 doi: 10.1115/1.4035061

Hensen Centnerová, L., van Duijnhoven, J., of Technology / ISIAQ, E. U., of Technology / NSVV, E. U., Groot Zwaaftink, M., NVKL, ... bba binnenmilieu (2021). *Programma van Eisen Gezonde Kantoren 2021*. Retrieved from https://www.binnenklimaattechniek.nl/wp-content/uploads/2022/01/Digitaal_Publicatie-PVE-Gezonde-kantoren_BinnenklimaatTechniek16.pdf

Holdsworth, B., & Sealey, A. (1993). Healthy buildings: A design primer for a living environment.. Retrieved from https://api.semanticscholar.org/CorpusID:107028836

Horr, Y. A., Arif, M., Kaushik, A., Mazroei, A., Elsarrag, E., & Mishra, S. (2017, 12). Occupant productivity and indoor environment quality: A case of GSAS. *International Journal of Sustainable Built Environment*, *6*(2), 476–490. Retrieved from https://doi.org/10.1016/j.ijsbe.2017.11.001 doi: 10.1016/j.ijsbe.2017.11.001

Horr, Y. A., Arif, M., Kaushik, A., Mazroei, A., Katafygiotou, M., & Elsarrag, E. (2016, 8). Occupant productivity and office indoor environment quality: A review of the literature. *Building and Environment*, *105*, 369–389. Retrieved from https://doi.org/10.1016/j.buildenv.2016.06.001 doi: 10.1016/j.buildenv.2016.06.001

Huber, C., Koch, D., & Busko, S. (2014, 01). An international comparison of user satisfaction in buildings from the perspective of facility management. , 1-15.

Ildiri, N., Bazille, H., Lou, Y., Hinkelman, K., Gray, W. A., & Zuo, W. (2022, 10). Impact of WELL certification on occupant satisfaction and perceived health, well-being, and productivity: A multi-office pre- versus post-occupancy evaluation. *Building and Environment*, *224*, 109539. Retrieved from https://www.sciencedirect.com/science/article/pii/S0360132322007697 doi: 10.1016/j.buildenv.2022.109539

Institute, I. W. B., Aguilar, A. M., for Disease Control, C., Protection, Research, K. W., Counsel, W. G. B., ... of Health Promotion, A. J. (2017). *WELL BUILDING STANDARD* (Tech. Rep.).

Jensen, P. A., & Van Der Voordt, T. J. (2019, 7). Healthy workplaces: what we know and what else we need to know. *Journal of Corporate Real Estate*, *22*(2), 95–112. Retrieved from https://doi.org/10.1108/jcre-11-2018-0045 doi: 10.1108/jcre-11-2018-0045

Jones, T., Baxter, M., & Khanduja, V. (2013, 1). A quick guide to survey research. *Annals of The Royal College of Surgeons of England*, *95*(1), 5–7. Retrieved from https://doi.org/10.1308/

003588413x13511609956372 doi: 10.1308/003588413x13511609956372

Joye, Y., & Dewitte, S. (2018, 10). Nature's broken path to restoration. A critical look at Attention Restoration Theory. *Journal of Environmental Psychology*, *59*, 1–8. Retrieved from https://doi.org/10.1016/j.jenvp.2018.08.006 doi: 10.1016/j.jenvp.2018.08.006

Kaplan, S. (1995, 9). The restorative benefits of nature: Toward an integrative framework. *Journal of Environmental Psychology*, *15*(3), 169–182. Retrieved from https://doi.org/10.1016/0272-4944(95)90001-2 doi: 10.1016/0272-4944(95)90001-2

Kim, J., & De Dear, R. (2012, 3). Nonlinear relationships between individual IEQ factors and overall workspace satisfaction. *Building and Environment*, *49*, 33–40. Retrieved from https://doi.org/10.1016/j.buildenv.2011.09.022 doi: 10.1016/j.buildenv.2011.09.022

Kropman, D., Appel-Meulenbroek, R., Bergefurt, L., & LeBlanc, P. (2022, 9). The business case for a healthy office; a holistic overview of relations between office workspace design and mental health. *Ergonomics*, *66*(5), 658–675. Retrieved from https://doi.org/10.1080/00140139.2022.2108905 doi: 10.1080/00140139.2022.2108905

Kwon, M., Remøy, H., & Van Den Dobbelsteen, A. (2019, 8). User-focused office renovation: a review into user satisfaction and the potential for improvement. *Property Management*, *37*(4), 470–489. Retrieved from https://doi.org/10.1108/pm-04-2018-0026 doi: 10.1108/pm-04-2018-0026

Kwon, M., Remøy, H., Van Den Dobbelsteen, A., & Knaack, U. (2018, 12). Personal control and environmental user satisfaction in office buildings: Results of case studies in the Netherlands. *Building and Environment*, *149*, 428–435. Retrieved from https://doi.org/10.1016/j.buildenv.2018.12.021 doi: 10.1016/j.buildenv.2018.12.021

LIMITED, E. S. P. (2024, 8). *WELL Building Standard | EcoInch Services.* Retrieved from https://www.ecoinch.com/well-building-standard/

Liu, H., Xu, X., Tam, V. W., & Mao, P. (2023, 9). What is the "DNA" of healthy buildings? A critical review and future directions. *Renewable sustainable energy reviews*, *183*, 113460. Retrieved from https://doi.org/10.1016/j.rser.2023.113460 doi: 10.1016/j.rser.2023.113460

Marberry, S. O., Guenther, R., & Berry, L. L. (2022, 6). Advancing human health, safety, and well-being with healthy buildings. *Journal of Hospital Management and Health Policy*, *6*, 18. Retrieved from https://doi.org/10.21037/jhmhp-21-63 doi: 10.21037/jhmhp-21-63

NEN 1814:2001 nl. (2001). Retrieved from https://www.nen.nl/nen-1814-2001-nl-67115

NEN-EN 12464-1:2021 en. (2021). Retrieved from https://www.nen.nl/nen-en-12464-1-2021-en-286866

Nicol, J., & Humphreys, M. (2002, 7). Adaptive thermal comfort and sustainable thermal standards for buildings. *Energy and Buildings*, *34*(6), 563–572. Retrieved from https://doi.org/10.1016/s0378-7788(02)00006-3 doi: 10.1016/s0378-7788(02)00006-3

Nowell, L. S., Norris, J. M., White, D. E., & Moules, N. J. (2017, 10). Thematic analysis. *International Journal of Qualitative Methods*, *16*(1), 160940691773384. Retrieved from https://doi.org/10.1177/1609406917733847 doi: 10.1177/1609406917733847

Obrecht, T. P., Kunič, R., Jordan, S., & Dovjak, M. (2019, 5). Comparison of Health and Well-

Being Aspects in Building Certification Schemes. *Sustainability*, *11*(9), 2616. Retrieved from https://doi.org/10.3390/su11092616 doi: 10.3390/su11092616

of Technology, E. U., & Dekkers, L. (2018, 9). *The difference in design outcome between a WELL building standard certified indoor environment and a BREEAM-NL certified indoor environment: assessment of 3 case studies.* Retrieved from https://research.tue.nl/files/77601949/Dekkers_0723047.pdf

Palacios, J., Eichholtz, P., & Kok, N. (2020, 8). Moving to productivity: The benefits of healthy buildings. *PloS one*, *15*(8), e0236029. Retrieved from https://doi.org/10.1371/journal.pone.0236029 doi: 10.1371/journal.pone.0236029

Pan, S., Xiong, Y., Han, Y., Zhang, X., Xia, L., Wei, S., ... Han, M. (2018, 4). A study on influential factors of occupant window-opening behavior in an office building in China. *Building and Environment*, *133*, 41–50. Retrieved from https://doi.org/10.1016/j.buildenv.2018.02.008 doi: 10.1016/j.buildenv.2018.02.008

Stokes, C. O., Brown, W., Delgado, C., Edgar, S., Henderson, D., Loveridge, S., ... Erickson, E. (2022). *RISK and SAFETY SERVICES* (Tech. Rep.). Retrieved from https://bpb-us-w2.wpmucdn.com/wordpress.ucsc.edu/dist/2/145/files/2024/06/Risk-and-Safety-Services-Strategic-Plan-PDF-Source-Doc.pdf

the WBDG Secure / Safe Committee. (2022). *Secure / Safe | WBDG - Whole Building Design Guide.* Retrieved from https://www.wbdg.org/design-objectives/secure-safe

V6.0.0, I.-U. U. C. (2020). *Toegankelijkheid - BREEAM-NL richtlijn.* Retrieved from https://richtlijn.breeam.nl/credit/toegankelijkheid-1230

van der Linden, K., & Vereniging, N. V. B. (2023). *Handboek Bouwfysische Kwaliteit Gebouwen* (Versie 3.1 ed.; Tech. Rep.). Retrieved from https://klimapedia.nl/wp-content/uploads/2021/10/NVBV-Handboek-BKG-v3.1_231014.pdf

Van Der Voordt, T., & Jensen, P. A. (2021, 11). The impact of healthy workplaces on employee satisfaction, productivity and costs. *Journal of Corporate Real Estate*, *25*(1), 29–49. Retrieved from https://doi.org/10.1108/jcre-03-2021-0012 doi: 10.1108/jcre-03-2021-0012

Van Der Voordt, T. J. (2004, 4). Productivity and employee satisfaction in flexible workplaces. *Journal of Corporate Real Estate*, *6*(2), 133–148. Retrieved from https://doi.org/10.1108/14630010410812306 doi: 10.1108/14630010410812306

Veitch, J. A., Newsham, G. R., Boyce, P. R., & Jones, C. (2008). Lighting appraisal, well-being and performance in open-plan offices: A linked mechanisms approach. *Lighting Research & Technology*, *40*(2), 133–151.

Vischer, J. C. (2007, 2). The effects of the physical environment on job performance: towards a theoretical model of workspace stress. *Stress and Health*, *23*(3), 175–184. Retrieved from https://doi.org/10.1002/smi.1134 doi: 10.1002/smi.1134

Vischer, J. C., & Wifi, M. (2016). *The effect of workplace design on quality of life at work*. Retrieved from https://doi.org/10.1007/978-3-319-31416-7_21 doi: 10.1007/978-3-319-31416-7\{_}21

Wallace, M., & Projects, C. C. L. (2015). *From principle to practice* (Tech. Rep.). Retrieved from https://www.cdacollaborative.org/wp-content/uploads/2017/04/Final-2015-CDA-From-Principle-to-Practice.pdf

Well. (n.d.). *WELL Standard*. Retrieved from https://v2.wellcertified.com/en/wellv2/overview

A

Appendix-A

Interview Protocol

Who am I?
My name is Maitri, and I'm a graduate student at TU Delft. I'm working on my thesis titled, *"Advancing Workplace Well-being: Optimising Integration health-centric design strategies for office environments in the Netherlands."*

What will I do with your information?
This interview will be recorded and transcribed for analysis, and all data will be anonymized. Your participation is voluntary, and no identifiable information will be included in the final report. All data will be securely stored and deleted once the research is completed.

A.0.1. Semi-Structured Interview Protocol

Why is this person here? You are being interviewed due to your expertise as a key stakeholder in the office building design process. Your role as an architect, contractor, corporate real estate well-being lead, well-being consultant, sustainability consultant, MEP designer, acoustic designer, lighting designer, or facility manager is critical in understanding the integration of well-being strategies into office projects.

Questions and guiding themes of the interview This interview focuses on understanding how well-being elements are incorporated into office building projects, identifying the challenges faced during this process, and gathering insights on current practices. Your expertise will help inform the development of a tailored framework suited to the Dutch context.

Sample Questions

- From your perspective, what defines a healthy office building?

- What well-being elements do you prioritize during the design or construction phases of your projects?
- How do you ensure that well-being goals align with the project's other objectives, such as cost and timelines?
- What guidelines or standards do you typically follow to integrate well-being into your projects (e.g., WELL, BREEAM)?
- Can you describe the role of different stakeholders (e.g., HR, Corporate Real Estate) in setting well-being goals for the project?
- What specific design considerations (e.g., air quality, lighting, thermal comfort) are most important in your projects, and at what phase are these introduced?
- What challenges do you encounter when trying to integrate well-being into office building projects, especially in the Dutch regulatory environment?
- How do you ensure that occupants' needs and preferences are considered during the design and execution of a project?
- In what ways are feedback and adjustments incorporated throughout the design and construction process to meet well-being goals?
- What improvements or strategies would you recommend for achieving better well-being outcomes in future projects?

A.0.2. Validation Interview Protocol

Why is this person here? You are being interviewed because of your expertise in well-being design for office environments. The purpose of this interview is to validate the proposed KPI levels and the design considerations developed for each phase of the project lifecycle.

Questions and guiding themes of the interview This validation session is aimed at confirming the applicability and practicality of the proposed framework. We will review the KPIs and phased design considerations, seeking your feedback on their accuracy and relevance.

Sample Questions

- Based on your experience, do the proposed KPIs align with the well-being goals typically pursued in office building projects?
- Are the optimal levels for these KPIs appropriate for the Dutch context, or would you recommend any adjustments?
- How feasible are the phased design considerations in real-world project timelines and budgets?
- Can you share any insights on how these KPIs and considerations can be better integrated into the existing project processes?
- In your opinion, how well does this framework address the challenges and gaps identified in current well-being design practices?
- Do you foresee any difficulties in adopting this framework for Dutch office building projects?
- What additional factors or elements should be considered to enhance the effectiveness of the proposed framework?

A.0.3. Consent Form

Before beginning the interview, participants were provided with a consent form outlining the purpose of the interview, the use of their data, and the measures taken to ensure their anonymity. A sample of the consent form is included below:

Delft University of Technology
HUMAN RESEARCH ETHICS

INFORMED CONSENT

You are being invited to participate in a research study titled *"Advancing Workplace Well-Being: Optimising Integration of Health-Centric Strategies for the Office Environments in the Netherlands' AEC Industry"* Maitri V Kallur, studying at TU Delft is carrying out this study. This research study aims to analyse the integration of healthy building strategies and indicators to develop a framework to facilitate their implementation in the Dutch AEC sector to help accelerate the integration of Indoor Environment Quality to improve occupant satisfaction in the workplace. This is done by investigating the current practices of designing a healthy office and design processes, particularly in collaboration with Deerns Nederland BV.

To gather the related information, you will be asked to participate in an online/offline interview of up to 60 minutes. The gathered data will be used for master thesis research only. You will be requested to provide your understanding and perspectives on what worked best for you, what you hope could have happened, what you wish already existed, and a few barriers and challenges you can learn from.

Your participation in this study is completely voluntary and you can stop participating at any time. You are also free to leave questions unanswered. As with any online activity, the risk of a breach is always possible. To the best of our ability, your answers in this study will remain confidential. We will minimize any risks using the following means: the audio/video of the interviewees will be recorded just for transcribing the information into text. This recording is only accessible to the main investigator (Maitri Kallur) who conducts the interview and will not be shared further. The transcribed information can be only accessed by the research team. After completion of the master's thesis, the recording and the transcripts will be permanently deleted. In addition, all information you provide is anonymized, which means that your name or contact details are not mentioned in quotes or transcripts, among other things. You may also rectify or delete the information immediately after the interview or request to review the transcript.

The aggregated anonymized information will be shared in the master thesis that will be uploaded to the TU Delft Education Repository, as required for inspection and possible further research, but will not contain any personal data that could identify you. No personal data will be shared outside the research team and will therefore not be mentioned in the master's thesis.

Below you can find the informed consent form of the research. Please tick the boxes to indicate your consent. For further information, questions, or comments, please send an email to Maitri Kallur (M.V.Kallur@student.tudelft.nl).

This appendix outlines the structured approach used to gather critical insights on well-being integration in office design, supporting the development and validation of the tailored framework for the Dutch context.

B

Appendix B

Before conducting the interviews, a brief study of project processes was carried out, which typically divides the AEC project life cycle into seven stages: client requirements briefing, conceptual design, detailed design, construction, handover, operation, and maintenance (Anumba, Kamara, & Cutting-Decelle, 2006). During the interviews, it was discovered that there is an additional stage known as the schematic design phase, which is crucial in healthy office building projects.

1. Project Definition and Brief Preparation:
   The process begins with establishing the project's objectives, key performance indicators (KPIs), and overarching vision. This stage is essential for ensuring that all stakeholders are aligned on the project's objectives and that it remains focused on establishing a healthy workplace. Early identification of these aspects establishes a solid basis for the entire project lifecycle (SWBC2, AR2).
2. Project Definition and Brief Preparation:
   The process begins with establishing the project's objectives, key performance indicators (KPIs), and overarching vision. This stage is essential for ensuring that all stakeholders are aligned on the project's objectives and that it remains focused on establishing a healthy workplace. Early identification of these aspects establishes a solid basis for the entire project lifecycle (SWBC2, AR2).
3. Schematic Design:
   The schematic design phase involves a broad understanding of the building's fundamental elements. Architects create fundamental plans that specify spatial requirements and zoning, whilst mechanical and electrical engineers conduct feasibility studies to identify broad-level factors such as the types of heating and cooling systems to be employed. It was noted during interviews that MEP experts already consider that ventilation must depend on CO_2 levels, leading to the design of a variable air volume system. This phase ensures the project begins with a solid, well-considered foundation (MEP1,AR2)
4. Conceptual Design: The conceptual design step refines the ideas from the schematic design

into more comprehensive plans. Space zoning is further refined, and MEP experts determine particular capacity for equipment such as air handling units. The ventilation systems designed at this stage are programmed to change based on CO_2 levels, maintaining ideal air quality. This phase strengthens the technical framework to meet the project's health and well-being objectives (SWBC2).

5. Detailed Design: The detail design step includes transforming the project's plans into precise, actionable designs. This step involves selecting specific materials and finishes, with assistance from interior designers who may have been involved or brought in. MEP expertise is critical in selecting installations, such as sensors, and establishing thresholds for systems established in previous phases. This guarantees that all components align with the project's goals, particularly indoor environmental quality (SWBC2,MEP1).
6. Technical Design: The technical design phase is the final step before building, in which all technical elements are determined. This phase includes selecting important items and systems ensuring that all design components are ready for implementation. The goal is to finalize the technical specs needed to bring the concept to reality (SWBC2).
7. Construction and handover: Construction follows the technical design, making the project's vision a reality. The handover step comprises commissioning to ensure the building matches the KPIs and vision goals. This procedure ensures that all components of the building function properly, creating a healthy and comfortable environment for its occupants (SWBC2).

Refinement of Design Stages:

Based on the literature, the first steps of the project process were improved through interviews with well-being experts and architects to match Dutch practices better. The stages have been modified to include project definition and brief preparation, schematic design, conceptual design, detail design, technical design, construction, and handover. This modification ensures a more precise and personalized approach to developing healthy working environments in the Netherlands.

By carefully monitoring each stage of the project process, from project vision setting to final commissioning, the project ensures that future occupants' health and well-being are emphasized throughout the office building's design and construction. This systematic approach is critical for attaining the goals of developing truly healthy working environments.

Table B.1: Themes and Codes from Thematic Analysis for Project Stages and Processes

Theme	**Code**	**Description**
Project Stages and Refinement	Initial Stages of Project Process	Identification of standard AEC project stages from literature.
	Refinement of Stages	Addition of the schematic design phase based on interview insights.
Vision and Goal Setting	Defining KPIs and Vision	Setting the project's health and well-being goals in the early stages.
Schematic Design	Broad-Level Considerations	Initial space zoning, architectural planning, and MEP feasibility studies.
	Ventilation System Design	Designing ventilation systems based on CO_2 levels, resulting in variable air volume systems.
Conceptual Design	Refined Zoning and Technical Planning	Refinement of zoning and technical systems, including system capacities.
	Integration of CO_2-Dependent Ventilation	Ensuring the adaptability of ventilation systems to CO_2 levels.
Detail Design	Detailed Planning and Selection	Selection of materials, finishes, and installations, with input from interior designers and MEP experts.
	Finalization of Design Details	Finalizing details like sensor placements and threshold settings.
Technical Design	Product and System Selection	Final selection of products and systems for construction.
Construction and Handover	Commissioning and Verification	Commissioning to verify that the building meets health and well-being KPIs.

C

Appendix C

C.1 Varying Healthy building definitions by literature and interview

C.1.1. Literature Perspective

Healthy office buildings are designed to promote their occupants' physical and mental well-being. These buildings provide safe and pleasant environments, encourage a sense of community, and motivate social interactions, essential components of overall health Heidari et al. (2016); Liu et al. (2023). Key characteristics include freedom from harmful elements, such as toxins and pollutants, and integrating features that enhance indoor environmental quality (IEQ), conserve energy, and support occupant well-being Holdsworth and Sealey (1993); **?**. A comprehensive definition involves maintaining and improving physical, mental, and social health, safety, convenience, and comfort in the built environment (Allen et al., 2017).

C.1.2. Stakeholder Perspectives

This subsection outlines the definition of a healthy office building according to the following involved stakeholders, and these definitions were derived from the interview insights.

- **Consultant**: Well-being encompasses both physical and mental aspects, including physical comfort, flexible policies for exercise, stress-free environments, safety, and job security. The impact of the physical environment on mental health is crucial, ensuring that occupants feel refreshed when they enter the office.
- **Well-being Lead in Project Team**: It focuses on creating positive effects beyond avoiding diseases or sick building syndrome. The goal is to enhance the well-being of employees and visitors through a holistic approach, similar to the World Health Organization's definition.
- **Architect**: Healthy offices are those where people are happy to work, free from complaints,

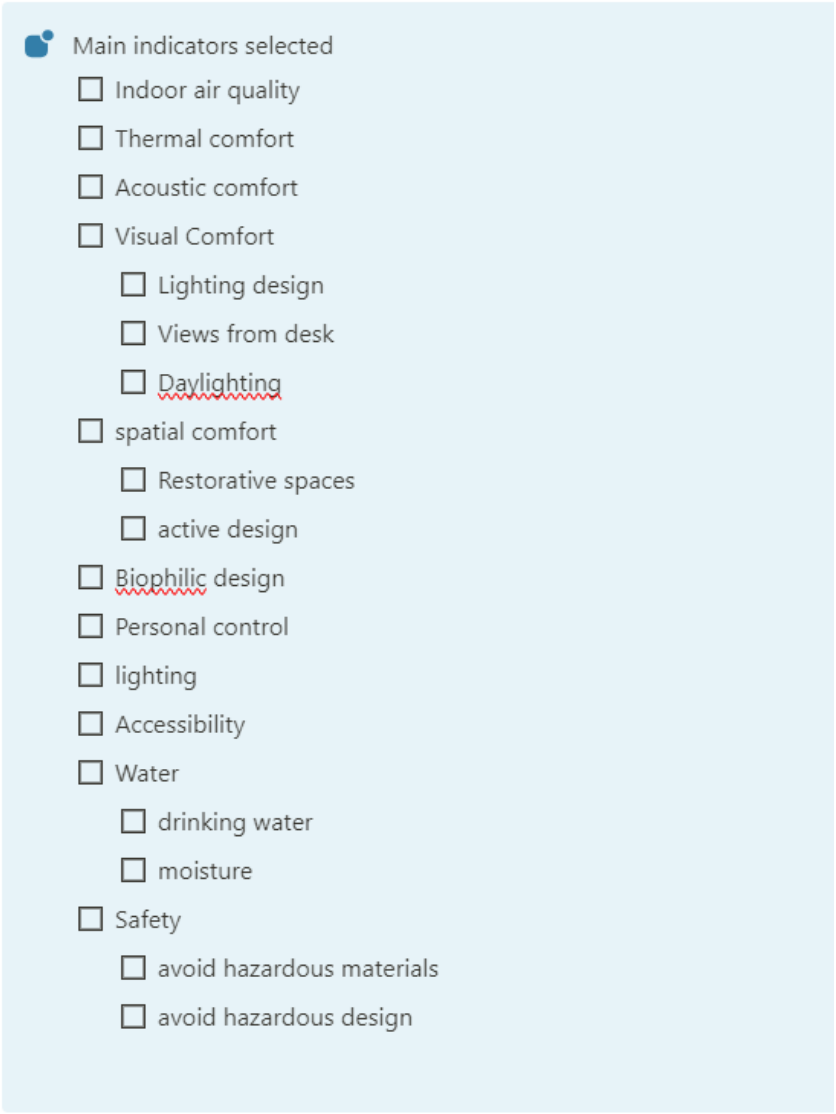
and can work in a friendly, compliant environment. Beyond regulatory requirements, happiness and well-being are prioritized.

- **Contractor**: A healthy workplace is comfortable, stimulating productivity and creativity and encouraging movement and health.
- **Facility Manager**: A well-being building provides comfort akin to home, with access to daylight, and maintains a healthy balance between work and personal life.
- **Lighting and Acoustics Expert**: Emphasizes good quality, flicker-free lighting, personal control over lighting and thermal conditions, and motivating lighting design. Acoustic comfort is also critical, ensuring low reverberation times.
- **Technical Specialist (M&P expert)**: A healthy building ensures no noticeable insulation issues, adequate air circulation to prevent CO_2 build-up, and no occupant complaints, indicating the right direction in design.
- **Well-being Expert**: Spaces should support occupants to be their best selves, promoting physical and mental health. Environments should enhance feelings of well-being, interaction, and productivity without causing any limitations.

D

Appendix:D

D.1 Performance Indicators consolidated levels



Indoor Air Quality

Main Requirements Table for Indoor Air Quality:

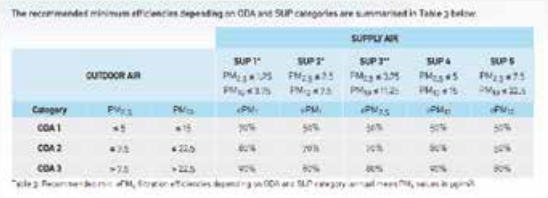
Parameter	Requirement	Range	Source
CO2 Levels	Maintain CO2 levels between 800 ppm - 400 ppm	**400 ppm to 800 ppm(whole building or varying occupancy) well**	Gezonde Kantooren
Carbon Monoxide (CO)	Keep CO levels between specified ranges	**5 ppm ≤ CO ≤ 8 ppm** (Good), **CO ≤ 9 ppm** (Max)	Gezonde Kantooren
Formaldehyde (HCOH)	Ensure formaldehyde concentration is below 30 µg/m³	**≤ 30 µg/m³**	Gezonde Kantooren
VOC Levels	Maintain VOCs within the range	**200 µg/m³ to 500 µg/m³**	Gezonde Kantooren
PM2.5 Levels	Keep Particulate Matter (PM2.5) within the specified range	**10 µg/m³ to 15 µg/m³**	Gezonde Kantooren
Ozone Levels (activated carbon filters	Ensure ozone concentration is below limits	**≤ 100 µg/m³ (51 ppb)**	WELL Standard
Radon Levels	Maintain safe radon concentration	**≤ 0.15 Bq/L (4 pCi/L)**	WELL Standard
Air Tightness/Permeability	Ensure air permeability is maintained at efficient levels	**0,15-0,3 dm³/s.m²**	Energy-efficient Construction (https://www.nieman.nl/specialismen/bouwtechniek-en-praktijk/luchtdicht-bouwen/eisen/)
Ventilation Rate (Office)	Maintain ventilation rates in office spaces	**1.39 - 2.08 L/s/m²**	Ventilation Standards
Ventilation Rate (Meeting Rooms)	Maintain ventilation rates in meeting rooms	**3.61 - 5.56 L/s/m²**	Ventilation Standards

☐ Air filters in ventilation

ODA 2 AND ODA 3 (depending on how high the concentration of gaseous and particulate matter is must be chosen)

SUP2 : Supply air category 2 as it is for the rooms for permanent occupation like

Example: Kindergardens, offices, hotels, residential buildings, meeting rooms, exhibition halls, conference halls, theaters, cinemas, concert halls.



Thermal Comfort

Requirements for Thermal Comfort

Parameter	Requirement	Range	source	requirement
Winter Comfort	Maintain indoor temperature between specified ranges	**Min 20°C to 22°C** (Outdoor: -10°C to 10°C)	Gezonde Kantooren	**Mandatory**
Summer Comfort	Maintain indoor temperature between specified ranges	**Max 24°C to 26°C** (Outdoor: 10°C to 30°C)	Gezonde Kantooren	**Mandatory**
Humidity	Relative indoor humidity control	**35% to 70%**	WELL	**Mandatory**
PMV Range	Maintain PMV (Predicted Mean Vote) within specified limits	**−0.5 < PMV < +0.5**	WELL	**Mandatory**
Air Velocity (Winter)	Control air velocity in winter	**0.15 m/s to 0.20 m/s**	Gezonde Kantooren	**Mandatory**
Air Velocity (Mid-Season)	Control air velocity in mid-season	**0.20 m/s to 0.25 m/s**	Gezonde Kantooren	**OPTIONAL**
Air Velocity (Summer)	Control air velocity in summer	**0.25 m/s to 0.30 m/s**	Gezonde Kantooren	**Mandatory**

Visual Comfort

☐

Table for Visual Comfort Requirements:

Parameter	Requirement	Range	Source	Status
Lighting Levels	Maintain optimal lighting levels based on task	**Office: 500 to 1000 lux**	NEN12464	**Mandatory**
		Circulation: 100 to 200 lux	NEN12464	**Mandatory**
		Canteen/Break: 200 to 500 lux	NEN12464	**Mandatory**
		Emergency/Staircase: 150 to 200 lux	NEN12464	**Mandatory**
Circadian Lighting	Ensure exposure to light levels at workstations for four hours	**Minimum 150-275 EML [136-250 melanopic EDI]**	WELL Standard	**Mandatory**
Glare (Electric)	Maintain glare index for various work spaces	**Office/Conference: ≤ 19**	NEN12464	**Mandatory**
		Canteen/Break: ≤ 22	NEN12464	**Mandatory**
		Circulation: ≤ 28	NEN12464	**Mandatory**
		Emergency/Staircase: ≤ 25	NEN12464	**Mandatory**
Solar Glare	Meet shading and glare control requirements	**Automated(optional) or Manual Shading**	WELL Standard/NEN17037	**Mandatory**
Lighting Uniformity	Maintain lighting uniformity for task areas	**Office/Conference: Uo ≥ 0.6**	NEN12464	**Mandatory**
		Canteen/Break, Circulation, ancillary facilities, emergency and staircase: Uo ≥ 0.4	NEN12464	**Mandatory**
Color Temperature	Maintain consistent correlated color temperature for all fixtures	**±200 K across fixtures**	WELL Standard	**Mandatory**
Flicker	Minimize flicker in electric lighting	**Pst LM ≤ 1.0**	WELL Standard	**Mandatory**
Daylight Access	Maintain daylight autonomy based on façade design	**70% of all workstations are within 5-8m of envelope glazing**	WELL Standard	**Mandatory**
Views from Desk	Ensure at least two of the requirements are met for all work desk and at least one of the requirements	**1. Maximize views of natural environments (e.g., greenery, parks).** **2. Minimize direct views of busy streets or distracting elements.**	Literature on visual comfort (DOI: 10.1177/147715350708627	**Atleast one of the requirements must be met**

	are met for the break rooms, conference rooms, cafeteria, reception and entrance lobby.	**3. Integrate indoor green walls or plants if outdoor views are limited.**		
Visual Distractions	Ensure incorporation of either of the requirements to reduce visual distractions.	**1. Position desks away from high-traffic areas to reduce visual distractions. (how far all desks or not)** **2.Tailor desk placement and views based on the office's urban or serene location.**		**Atleast one of the requirements must be met**

Acoustic Comfort

☐ **1. Maximum Noise Levels and Reverberation time** (NVBV)

Space Category	Sound Pressure Level Due to Outside Noise (LAeq in dB)	Installation Sound Pressure Level (LIA in dB)	Acceptable Background Noise Levels (dB(A))	Max Reverberation Time (Furnished Space)
Board rooms/Rooms with High Speech Privacy	< 35 dB	< 35 dB	35-40 dB	0.4s
Meeting rooms/Rooms with Moderate Speech Privacy	< 40 dB	< 35 dB	35-40 dB	0.6s
Enclosed Private Workplace (1-4 people)	< 40 dB	< 35 dB	35-40 dB	0.5s
Open Clustered Workplace (4-8 people)	< 40 dB	< 40 dB	40 dB	0.5s

Mandatory: Noise levels should stay within the above thresholds to ensure comfort and privacy across different spaces.

Mandatory: Proper reverberation control is essential for speech clarity and overall comfort in different privacy settings.

☐ **3. Sound Insulation Between Rooms (Indoor Insulation - NVBV)**

Space Category	Airborne Sound Level Difference to Living Spaces (dB)	To Traffic Spaces (dB)	To Sanitary Spaces (dB)	Impact Sound Level (Living/Traffic Spaces)	Tenant/User Separation (dB)
Board rooms/Rooms with High Speech Privacy	≥ 45 dB	≥ 36 dB	≥ 48 dB	≤ 57/≤ 67 dB	≥ 50 dB
Meeting rooms/Rooms with Moderate Speech Privacy	≥ 42 dB	≥ 33 dB	≥ 48 dB	≤ 57/≤ 67 dB	≥ 50 dB
Enclosed Private Workplace (1-4 people)	≥ 39 dB	≥ 27 dB	≥ 48 dB	≤ 57/≤ 67 dB	≥ 50 dB
Open Clustered Workplace (4-8 people)	≥ 39 dB	≥ 27 dB	≥ 48 dB	≤ 57/≤ 67 dB	≥ 50 dB

Mandatory: Adhering to these insulation levels ensures speech privacy and prevents sound leakage between rooms.

☐ **4. Speech Privacy Levels** (Voice Volume)

Speech Privacy Level	Normal Voice Volume	Raised Voice Volume	Loud Voice Volume
High Speech Privacy	55-60 dB(A)	65 dB(A)	70 dB(A)

Optional: Establishing these voice volume levels can help maintain privacy and reduce distractions in collaborative or private settings.

Open Workspaces	Minimum NRC or Alpha-w (Ceiling Area)	0.75 - 0.90 for 75% to 100% of ceiling area
	Minimum Furniture Height & NRC or Alpha-w	Partial height barriers ≥ 4 ft with NRC or Alpha-w ≥ 0.70 between opposing workstations
Conferencing & Learning Areas	Minimum NRC or Alpha-w (Ceiling Area)	0.75 - 0.90 for 50% to 100% of ceiling area
	Minimum NRC or Alpha-w (Walls)	0.75 - 0.80 on at least 25% of one or two perpendicular walls
Dining Areas	Minimum NRC or Alpha-w (Ceiling Area)	0.75 - 0.90 for 50% to 100% of ceiling area

Mandatory: Sound-absorbing materials must meet these requirements to control noise in different areas effectively.

☐ **6. Zoning and Acoustic Treatment**:

☐ **Acoustic Zoning**: Use acoustic treatments to create **zones** for different activities, ensuring that **collaborative areas do not disturb focused work(consideration)**.

☐ **Sound Masking Systems**: Implement **sound-masking systems** to reduce noise distractions in **open-plan areas**.

Optional: Zoning and sound-masking systems enhance the acoustic environment in open and collaborative spaces, making it more adaptable and comfortable for different activities.

Water Control Requirements

1. Moisture Control Checklist

Atleast two of optional aspects must be met

Requirement	Details	Status
Capillary Break Methods	Implement between exterior cladding and weather-resistant barriers (Free-Draining Spaces). (either one)	**Optional**
Use Non-Porous Materials either or (what spaces)	Use non-porous materials like closed-cell foams, waterproofing membranes, or metal between porous materials.	**not needed if moisture sensitive materials protection is done**
Moisture-Sensitive Materials Protection either or (what spaces)	Use moisture-resistant materials or finishes for surfaces likely to be exposed to liquid water (e.g., finished floors).	**Not needed if there is use of non-porus materials**
Areas of Focus for Moisture Resistance	Apply moisture-resistant materials in basements, bathrooms, janitorial rooms, kitchens, and areas at or below grade.	**Mandatory**
Condensation Prevention	Prevent condensation(by either using vapor barriers on walls and cielings or by installing dehumidifiers in basements)on cold surfaces such as basements, slab-on-grade floors, inside exterior walls, and glazing	**Mandatory**
Vapour Pressure	Manage vapor pressure differentials to prevent condensation. Useful but not critical in all regions.	**Optional**
Entryway Design	Implement(what) strategies to minimize water ingress at entryways. Important but depends on site-specific moisture risks.	**Optional**

2. Drinking Water Checklist

Requirement	Status	Details
Accessibility to Drinking Water	**Mandatory**	At least one dispenser per floor, within **100 ft** (3-4min walking distance) of all regularly occupied spaces.
Direct Water Supply for Dispensers	**Mandatory**	Dispensers must be directly piped to the building’s water supply
Bottle-Refilling Design for Fountains	**Mandatory**	Newly installed drinking water f**ountains(check terms)** should be designed for bottle-refilling.

3. Drinking Water Quality Parameters (Check if water meets the following)

Parameter	Threshold	Status
Arsenic	≤ 0.01 mg/L	**Mandatory**
Cadmium	≤ 0.003 mg/L	**Mandatory**
Chromium (total)	≤ 0.05 mg/L	**Mandatory**
Copper	≤ 2 mg/L	**Mandatory**
Fluoride	≤ 1.5 mg/L	**Mandatory**
Lead	≤ 0.01 mg/L	**Mandatory**
Mercury (total)	≤ 0.006 mg/L	**Mandatory**
Nickel	≤ 0.07 mg/L	**Mandatory**
Nitrate	≤ 50 mg/L as Nitrate	**Mandatory**
Nitrite	≤ 3 mg/L as Nitrite	**Mandatory**

Total chlorine	≤ 5 mg/L	**Optional**
Aluminum	≤ 0.2 mg/L	**Optional**
Chloride	≤ 250 mg/L	**Optional**
Manganese	≤ 0.05 mg/L	**Mandatory**
Iron	≤ 0.3 mg/L	**Optional**
Silver	≤ 0.1 mg/L	**Optional**
Sodium	≤ 270 mg/L	**Optional**
Sulfate	≤ 250 mg/L	**Optional**
Zinc	≤ 5 mg/L	**Optional**
Total Dissolved Solids (TDS)	≤ 500 mg/L	**Mandatory**
Free Chlorine	≤ 1.25 mg/L	**Optional**
Magnesium	>10 mg/L	**Mandatory**
Calcium	>30 mg/L	
Pre test the water for	**turbidity, coliforms, pH, TDS, chlorine, arsenic, lead, copper, nitrate, benzene** before use.	**Mandatory**

4. Pre-Test Parameters for Drinking Water (combine with the other)

Parameter	Status	Details
Turbidity, coliforms, pH, TDS, chlorine, arsenic, lead, copper, nitrate, benzene	**Mandatory**	These water quality indicators must be tested before use.

7. Water Leak Control Checklist(leak detection)

Requirement	Status	Details
Manual or automatic shut-off for hard-piped fixtures	**Mandatory**	All hard-piped fixtures must have shut-off mechanisms at the point of connection.
Backflow prevention in water treatment devices	**Mandatory**	Water treatment devices with drain lines must have backflow prevention mechanisms.

Summary of Key Elements:

Mandatory Requirements:

1. **Moisture Control**: Air tightness testing, capillary break methods, moisture-sensitive materials protection, areas of focus for moisture resistance, condensation prevention, minimizing moisture intrusion, continuous drainage plane.
2. **Drinking Water**: Accessible water dispensers, water quality parameters (e.g., arsenic, cadmium, lead, etc.), pre-test parameters, sampling methods, water leak control.
3. **Water Quality Testing**: Key parameters such as turbidity, coliforms, lead, and others must be tested.
4. **Sampling Locations**: Mandatory locations for water sampling across the building.

Optional Requirements:

- **Vapor Pressure Management**: May depend on specific climate conditions.
- **Entryway Design**: Optional for moisture control depending on the location.
- **Chlorine, Aluminum, Sodium**: These parameters are important but can vary based on local water quality regulations.

Source: Van der Lugt, W., Euser, S.M., Bruin, J.P., & den Boer, J.W. (2019). Wide-scale study of 206 buildings in the Netherlands from 2011 to 2015 to determine the effect of drinking water management plans on the presence of *Legionella* spp. *Water Research*, 161, 581-589. DOI: 10.1016/j.watres.2019.06.043.

Safety

Avoid Hazardous Materials Checklist

1. VOC Emissions Restriction for Furniture, Architectural, and Interior Products

Note : **Mandatory Compliance Testing :** VOC thresholds following **EN 16516-1:2017** testing methods must be applied to ensure compliance.

Requirement	Status	Details
VOC Emission Control	**Mandatory**	At least 75% - 90% of surface area of building materials must meet European Union LCI VOC thresholds.
Specific VOC Compound Limits	**Mandatory**	At least 75% - 90% of surface area of building Comply with VOC limits for individual compounds (like **Formaldehyde ≤ 100 µg/m³**, **Toluene ≤ 2900 µg/m³**, **Xylene ≤ 500 µg/m³**).

2. Mercury Restriction for Lamps

Requirement	Status	Details
Mercury Content in Lighting	**Mandatory**	Newly installed fluorescent, metal halide, and sodium lamps must meet maximum mercury content limits:
Compact, integral ballast	**3.5 mg**	**Mandatory**
Compact, non-integral ballast	**3.5 mg**	**Mandatory**
T-5, circular	**9 mg**	**Mandatory**
T-5, linear	**2.5 mg**	**Mandatory**
T-8, eight-foot	**10 mg**	**Mandatory**
T-8, four-foot	**3.5 mg**	**Mandatory**
High-Pressure Sodium (400 W or less)	**10 mg**	**Mandatory**
High-Pressure Sodium (over 400 W)	**32 mg**	**Mandatory**

3. Restriction on Hazardous Components

Requirement	Status	Details
Hazardous Component Restrictions in Electrical Systems	**Mandatory**	Newly installed fire alarms, meters, sensors, relays, thermostats, and load break switches must:
Mercury Limit	≤ 0.1% (1000 ppm)	**Mandatory**
Lead Limit	≤ 0.01% (100 ppm)	**Mandatory**

4. Lead-Free Paint

Requirement	Status	Details
Lead-Free Paint	**Mandatory**	Newly installed paints must either:
Lead Concentration	≤ 100 ppm (0.01%) by weight	**Mandatory**
No Added Lead Carbonates/Sulfates	**Mandatory**	Paints must have no added lead carbonates or sulfates.

Avoid Hazardous Design Checklist

Requirement	Details	Status
Emergency Exit Accessibility	Provide clear access to emergency exits, ensuring exit routes are unobstructed and clearly marked.	**Mandatory**
Slip-Resistant Flooring	Use slip-resistant materials for flooring, especially in areas prone to moisture (e.g., entryways, bathrooms, kitchens).	**Mandatory**
Buffered Electrical Services	Ensure electrical services are located (at least 500 mm)away from circulation paths and should be placed at a height 900 mm-1200 mm from floor level, to not create obstructions or hazards.	**Mandatory**
Access Control at Entrances (security)	Implement access control systems at building entrances to enhance safety and security.	**Mandatory**
Minimize Uncontrolled Vantage Points (security)	Design entrances to minimize exposure to uncontrolled vantage points and direct lines of sight.	**Optional**

Sources: WBDG Secure/Safe Design Objectives, Arizona Corporate Interiors

Spatial Quality:

Spatial Quality Checklist

1. Active Office Design

☐ **Mandatory**: Encourage walking by placing facilities such as restrooms, kitchens, and breakout spaces away from workstations(range).

☐ **Optional**: Design an open staircase that is as prominent as elevators, encouraging movement between floors.

2. Flexible Office Design

☐ **Mandatory**: Provide a mix of open-plan areas and private spaces to support both collaboration and focused work (≥25% private or quiet zones).

☐ **Mandatory**: Implement zoning with varied work settings, including adjustable partitions to create flexible environments for different tasks.

☐ **Optional**: Incorporate multi-functional spaces to serve multiple purposes, ensuring efficient space usage(this and previous point are same).

☐ **Mandatory**: Design layouts that promote movement and interaction, minimizing congestion in circulation paths(how to do this).

3. Restorative Spaces

☐ **Mandatory**: Include breakout spaces for relaxation and informal meetings (minimum 1 breakout space per 20 employees)(well calculation).

☐ **Optional**: Provide quiet zones or restorative areas where employees can take mental breaks and recharge(this and next one sounds same list types of restorative spaces for example then decide frequency).

☐ **Optional**: Incorporate wellness areas, such as meditation rooms, to support employee well-being.

4. Spaces Encouraging Interaction and Collaboration

☐ **Mandatory**: Create collaboration zones that encourage interaction and brainstorming among employees from different teams.

☐ **Optional**: Design flexible meeting rooms with movable walls or partitions to accommodate different group sizes and activities.

☐ **Optional**: Establish co-working spaces that encourage interaction across departments.

☐ **Optional**: Use interactive technology, such as smart whiteboards or video conferencing tools, to facilitate collaboration.

☐ **Mandatory**: Place social areas like coffee stations and lounges in central locations to encourage spontaneous interaction.

5. Facilities toilets ,locker rooms parking, waste disposal , kitchen.

☐ **Mandatory**: Ensure that **restrooms** are easily accessible from all workstations and common areas, but placed at a distance that encourages walking and movement throughout the office (approximately 30-50 meters).

☐ **Mandatory**: **Locker rooms** should be located near entrances or parking areas to provide convenience for employees who commute by bike or need changing facilities.

☐ **Mandatory**: Ensure **parking areas** are easily accessible(**Optional** : separated from the main building by a walking route, promoting physical activity) while ensuring safety and security.

☐ **Mandatory**: **Waste disposal areas** should be clearly zoned and positioned in strategic locations that minimize odor and inconvenience, while still being accessible to both staff and cleaning personnel.

☐ **Mandatory**: **Kitchens** and break rooms should be spaced away from workstations, encouraging movement but ensuring ease of access for daily use. Ensure enough space and facilities are provided to meet the needs of the entire staff (e.g., sinks, refrigerators, seating).

☐ **Mandatory: Based on the results of the occupant survey incorporate other facilities(such as lactation rooms, children playrooms etc) as per occupant requirement**

Table Format: Spatial Quality Checklist

Ensure implementation of at least 1-2 optional requirements

Category	Requirement	Status
Active Office Design	Centralized facilities (restrooms, kitchens) placed away from workstations to encourage walking.	**Mandatory**
	Passageways must be ≥1500 mm wide, with turning space every 75 m.	**Mandatory**
	Open staircases should encourage movement between floors.	**Optional Implement one staircase if feasible**
Flexible Office Design	Provide a mix of open-plan areas and private spaces (≥25% private or quiet zones).	**Mandatory**
	Zoning with varied work settings and adjustable partitions for flexible environments.	**Mandatory**
	Incorporate multi-functional spaces for efficient space usage.	Implement **at least 1** multi-functional space.
	Layouts should promote movement and reduce congestion.	**Mandatory**
Restorative Spaces	Include breakout spaces for relaxation (≥1 per 20 employees).	**Mandatory**
	Provide quiet or restorative zones for mental breaks.	**Mandatory** Implement **at least 1** restorative area.
	Incorporate wellness areas, such as meditation rooms.	Implement **at least 1** restorative area.
Spaces Encouraging Interaction and Collaboration	Create central collaboration zones for brainstorming and interaction across teams.	**Mandatory**
	Design flexible meeting rooms with movable walls/partitions.	**Optional**
	Establish co-working spaces to promote cross-departmental interaction.	**Optional**
	Use interactive technology (e.g., smart whiteboards, video conferencing, glass walls or glass table tops) to facilitate collaboration.	**Optional Implement in a form as per client requirement**
	Place social areas (coffee stations, lounges) in central locations to encourage spontaneous interactions.	**Mandatory**

References

- De Croon, E. M., Sluiter, J. K., Kuijer, P. P., & Frings-Dresen, M. H. (2005). The effect of office concepts on worker health and performance: A systematic review of the literature. Ergonomics, 48(2), 119-134.
- Duffy, F. (1997). The New Office. Conran Octopus.
- Foster, S., Hooper, P., Knuiman, M., Bull, F., & Giles-Corti, B. (2014). Safe RESIDE: the relationship between the built environment and physical activity in adults. Preventive medicine, 69, 29-34.
- Laing, A., Duffy, F., Jaunzens, D., & Willis, S. (1998). New Environments for Working. E&FN Spon.

- Nicoll, G. (2007). Spatial measures associated with stair use. American Journal of Health Promotion, 21(4), 346-352.
- Rashid, M. (2019). The Effect of Workplace Design on Employee Health, Well-being, and Performance. Routledge.
- Salmon, J., Owen, N., Bauman, A., Schmitz, M. K., & Booth, M. (2000). Leisure-time, occupational, and household physical activity among professional, skilled, and less-skilled workers and homemakers. Preventive medicine, 30(3), 191-199.
- Vischer, J. C. (2007). The effects of the physical environment on job performance: Towards a theoretical model of workspace stress. Stress and Health: Journal of the International Society for the Investigation of Stress, 23(3), 175-184.
- Van der Voordt, T. J. M. (2004). Productivity and employee satisfaction in flexible workplaces. Journal of Corporate Real Estate, 6(2), 133-148.

Biophilic Design

Biophilia Requirements Checklist

Note:
at least
7-8 of the 17 Optional requirements should be implemented across different categories (e.g., Visual Connection to Nature, Auditory Elements, Multisensory Approach).

1. Visual Connection to Nature

☐ **Optional**: **Glass Walls for Daylight** – Use glass walls to maximize daylight penetration in at least **30%** of interior spaces.(daylight)

☐ **Mandatory**: **Large Windows for Outdoor Views** – Ensure at least **50%** of all regularly occupied spaces have access to natural daylight and views of outdoor landscapes.

☐ **Optional**: **Plants in Workspaces** – Place at least one plant for every **5 workstations** in workstations, meeting rooms, and common areas.

☐ **Optional**: **Green Walls or Vertical Gardens** – Install one green wall or vertical garden for every **100 m²** of floor area to enhance natural visibility.

☐ **Optional**: **Earth Tones and Natural Materials** – Use natural colors and materials (e.g., wood, stone) in at least **20%** of visible surfaces.

2. Auditory Elements

☐ **Optional**: **Natural Soundscapes for auditory relaxation** – Use sound systems to play natural sounds (e.g., flowing water, birdsong) in relaxation areas or meditation spaces.

3. Multisensory Approach

☐ **Optional**: **Water Features** – Incorporate at least one water feature (e.g., fountain, pond) in communal areas for visual and auditory effects.

☐ **Optional**: **Natural Scents** – Use diffusers with natural scents in at least one communal area per floor.

☐ **Optional**: **Responsive Features** – Install interactive features that respond to occupant presence (e.g., light or sound changes) in high-traffic areas.

☐ **Optional**: **Natural Materials in Design** – Incorporate natural materials such as tree limbs, stone, or moss in the design of at least **20%** of frequently used spaces(what spaces).

4. Natural Analogues

☐ **Optional**: **Layouts Mimicking Nature** – Design layouts that mimic natural landscapes, with walking paths that encourage exploration and movement.

☐ **Optional**: **Natural Dividers** – Use tall plants or other natural elements as dividers to increase privacy in at least **15%** of shared spaces.

☐ **Optional**: **Canopy-Like Structures** – Design canopy-like structures (overhead coverings) in high-traffic or common areas to mimic the feeling of being under trees.

☐ **Optional**: **Artwork or Projections Depicting Nature** – Place natural artwork or digital projections of nature scenes in lobbies, corridors, or waiting areas (at least one per floor).

☐ **Optional**: **Fractal Patterns in Design** – Utilize fractal patterns (repeated natural patterns) in design features like walls, flooring, or partitions in at least one communal space per floor.

5. Nature of the Space

☐ **Mandatory**: **Clear Sightlines and Private Spaces (Prospect and Refuge)** – Design open spaces with clear sightlines (prospect) while providing at least **one enclosed private space (refuge)** for every 20 employees.

☐ **Optional**: **Green Corridors or Courtyards** – Incorporate a green corridor, courtyard, or planting area in at least one major circulation path or central area of the project.

Table Format: Biophilia Requirements Checklist

Note:
at least
7-8 of the 17 Optional requirements should be implemented across different categories (e.g., Visual Connection to Nature, Auditory Elements, Multisensory Approach).

Category	Requirement	Status
Visual Connection to Nature	Large windows for outdoor views in 50% of regularly occupied spaces.	**Mandatory**
	Place at least one plant for every 5 workstations.	**Optional**
	Install one green wall or vertical garden for every 100 m² of floor area.	**Optional**
	Use earth tones and natural materials in 20% of visible surfaces.	**Optional**
	Use glass walls to increase daylight in 30% of interior spaces.	**Optional**
Auditory Elements	Play natural soundscapes in relaxation or meditation areas.	**Optional**
	Install auditory soundscapes in at least one relaxation or quiet zone.	**Optional**
Multisensory Approach	Incorporate one water feature in communal areas.	**Optional**
	Use diffusers with natural scents in one communal area per floor.	**Optional**
	Install responsive features that react to occupant presence (e.g., light or sound changes).	**Optional**
	Use natural materials in 20% of frequently used spaces.	**Optional**
Natural Analogues	Use organic shapes in 10% of furniture and architecture.	**Optional**
	Design layouts that mimic natural landscapes.	**Optional**
	Use tall plants as dividers in 15% of shared spaces.	**Optional**
	Design canopy-like structures in high-traffic areas.	**Optional**
	Place nature-inspired artwork or digital projections in one communal space per floor.	**Optional**
	Utilize fractal patterns in one communal space per floor.	**Optional**
Nature of the Space	Provide clear sightlines (prospect) and private spaces (refuge) for every 20 employees.	**Mandatory**
	Incorporate a green corridor, courtyard, or planting area in circulation paths.	**Optional**

Sources:

- Alvarsson, J. J., Wiens, S., & Nilsson, M. E. (2010). Stress Recovery during Exposure to Nature Sound and Environmental Noise. *International Journal of Environmental Research and Public Health*, 7(3), 1036–1046.
- Becker, F. D., & Steele, F. (1995). *Workplace by Design: Mapping the High-Performance Workscape*. Jossey-Bass.
- Bringslimark, T., Hartig, T., & Patil, G. G. (2009). The psychological benefits of indoor plants: A critical review of the experimental literature. *Journal of Environmental Psychology*, 29(4), 422–433.
- Browning, W. D., Ryan, C. O., & Clancy, J. O. (2014). 14 Patterns of Biophilic Design. *Terrapin Bright Green*.
- Fjeld, T., Veiersted, B., Sandvik, L., Riise, G., & Levy, F. (1998). The effect of indoor foliage plants on health and discomfort symptoms among office workers. *Indoor and Built Environment*, 7(4), 204-209.
- Gillis, K., & Gatersleben, B. (2015). A review of psychological literature on the health and wellbeing benefits of biophilic design. *Buildings*, 5(3), 948-963.

- Gozalo, G. R., Morillas, J. M. B., González, D. M., Moraga, P. A., & Vílchez-Gómez, R. (2015). Relationships among satisfaction, noise perception, and use of urban green spaces. *Science of the Total Environment*, 524, 438-450.
- Heerwagen, J. H. (2000). Green buildings, organizational success, and occupant productivity. *Building Research & Information*, 28(5-6), 353-367.
- Joye, Y., & Dewitte, S. (2018). Nature's broken path to restoration: A critical look at Attention Restoration Theory. *Journal of Environmental Psychology*, 59, 1-8.
- Kaplan, R. (1995). The restorative benefits of nature: Toward an integrative framework. *Journal of Environmental Psychology*, 15(3), 169-182.
- Kellert, S. R., Heerwagen, J., & Mador, M. (2008). *Biophilic Design: The Theory, Science, and Practice of Bringing Buildings to Life*. John Wiley & Sons.
- Nicol, J. F., & Humphreys, M. A. (2002). Adaptive thermal comfort and sustainable thermal standards for buildings. *Energy and Buildings*, 34(6), 563-572.
- Soderlund, J., & Newman, P. (2017). Biophilic architecture: A review of the rationale and outcomes. *AIMS Environmental Science*, 4(3), 324-338.
- Ulrich, R. S. (1984). View through a window may influence recovery from surgery. *Science*, 224(4647), 420-421

Personal Control

Personal Control Requirements Checklist

1. Thermal Control

☐ **Mandatory**: **Control Range** – Allow temperature adjustments within a range of

- **20°C to 22°C during winter (with plus or minus 2°C flexibility)**.
- **24°C to 26°C during summer (with plus or minus 2°C flexibility).**

☐ **Optional**: **Shared Control for Small Groups** – For groups of **2-6 people**, ensure that controls are accessible to all members to avoid conflicts.

☐ **Optional**: **Operable Windows** – Install operable windows such that for each floor, the **openable window area** is at least 4% the area of the **occupiable space**.to allow fresh air regulation and personal temperature control.

2. Lighting Control

☐ **Mandatory**: **Lighting Zones** – Implement lighting zones for small groups (2-4 people) to customize light settings based on activities.

- **Tier 1**: One zone per **650 ft²** or **10 occupants**.
- **Tier 2**: One zone per **320 ft²** or **5 occupants**.

☐ **Optional**: **Individual or Group Lighting Control** – Offer intuitive, easy-to-use lighting controls either for every task lighting.

3. Air Quality Control

☐ **Mandatory**: **Ventilation Control** – Allow occupants to adjust airflow at their workstations using ventilation grilles or diffusers.

☐ **Optional**: **CO2 Monitors** – Install CO2 monitors to give feedback on air quality and enable users to adjust ventilation or open windows as needed.

3.1 Operable windows

☐ At least 75% of the regularly occupied spaces have operable windows, ensuring that for each floor, the openable window area is atleast 4% the area of occupied spaces.

4. Acoustic Control

☐ **Optional**: **Sound Masking** – Provide personal sound-masking devices or localized noise control options.

☐ **Optional**: **Quiet Zones** – Designate quiet zones where users can control noise levels for focused work.

5. Privacy Control

☐ **Optional**: **Adjustable Partitions** – Offer movable partitions for flexible privacy adjustments at workstations.

☐ **Optional**: **Plant-Based Dividers** – Use tall plants or green walls as natural (movable)dividers to enhance privacy while maintaining a biophilic connection.

☐ **Optional**: **Screens and Blinds** – Provide occupants with easy-to-use screens or blinds to adjust visual privacy at their desks or in meeting spaces.

Table Format: Personal Control Requirements Checklist

Category	Requirement	Status
Thermal Control	Provide adjustable heating and cooling options at workstations.	**Mandatory**
	Allow temperature adjustments within a range of 19°C to 26°C.	**Mandatory**
	Ensure shared control for groups of 2-6 people.	**Optional**
	Install operable windows for fresh air regulation and temperature control.	**Optional**

	Provide a user-adjustable thermostat for individual control.	**Optional**
	Provide desk or ceiling fans for personal airspeed control.	**Optional**
Lighting Control	Provide dimming controls for adjustable brightness and glare reduction.	**Mandatory**
	Implement lighting zones for small groups, based on Tier 1 or Tier 2 requirements.	**Mandatory**
	Offer intuitive lighting controls for individual or group use.	**Optional**
Air Quality Control	Allow occupants to adjust airflow using ventilation grilles or diffusers.	**Mandatory**
	Install CO2 monitors for air quality feedback and control.	**Optional**
Acoustic Control	Provide personal sound-masking devices or localized noise control.	**Optional**
	Designate quiet zones with noise control options.	**Optional**
	Ensure acoustic controls enhance privacy in focused workspaces.	**Optional**
Privacy Control	Offer movable partitions for flexible privacy adjustments.	**Optional**
	Use plant-based dividers for natural privacy and biophilic connection.	**Optional**
	Provide screens or blinds for visual privacy adjustments.	**Optional**
Combined Control Interfaces	Install intuitive control panels or apps for lighting, temperature, air, and acoustic adjustments.	**Mandatory**
	Implement shared control in small groups (2-4 people) where individual control isn't feasible.	**Optional**
	Use zone-based control for larger office spaces, with each zone serving 4-6 people.	**Optional**

References:

- Pan, S., et al. (2018). A Study on Influential Factors of Occupant Window-Opening Behavior in an Office Building in China. Building and Environment, 133, 41-50.
- Brager, G., et al. (2004). Operable Windows, Personal Control, and Occupant Comfort. ASHRAE, 110(2), 17-35.
- Liu, J., et al. (2019). Occupants' Thermal Comfort and Perceived Air Quality in Natural Ventilated Classrooms During Cold Days. Building and Environment, 158, 73-82.
- Stazi, F., et al. (2017). Indoor Air Quality and Thermal Comfort Optimization in Classrooms Developing an Automatic System for Windows Opening and Closing. Energy and Building, 139, 732-746.
- Catalina, T., & Iordache, V. (2012). IEQ Assessment on Schools in the Design Stage. Building and Environment, 49, 129-140.
- Gao, J., et al. (2014). Ventilation System Type, Classroom Environment Quality and Pupils' Perception and Symptoms. Building and Environment, 75, 46-57.
- Wang, Y., et al. (2014). Indoor Air Environment and Night Cooling Energy Efficiency of a Southern German Passive Public School Building Operated by the Heat Recovery Air Conditioning Unit. Energy and Building, 81, 9-17.
- Almeida, R.M.S.F., et al. (2016). Thermal Comfort Models and Pupils' Perception in Free-running School Buildings of Mild Climate Country. Energy and Buildings, 111, 64-75.
- Becker, F. D., & Steele, F. (1995). Workplace by Design: Mapping the High-Performance Workscape. Jossey-Bass.
- Jiang, J., et al. (2018). A Study on Pupils' Learning Performance and Thermal Comfort of Primary Schools in China. Building and Environment, 134, 102-113.
- Nicol, J. F., & Humphreys, M. A. (2002). Adaptive thermal comfort and sustainable thermal standards for buildings. *Energy and Buildings, 34*(6), 563-572
- Kim, J., & de Dear, R. (2012). Nonlinear relationships between individual IEQ factors and overall workspace satisfaction. *Building and Environment, 49*, 33-40

- Zhang, H., Arens, E., & Kim, D. (2010). Comfort, perceived air quality, and work performance in a low-power task-ambient conditioning system. *Building and Environment, 45*(1), 29-39.

Accessibility

☐

Accessibility Requirements Checklist

1. Access to the Building

☐ **Mandatory**: **Step-Free Access** – Provide threshold- and step-free access to the main entrance (same level, gentle slope, or driveway) from the plot boundary.

☐ **Mandatory**: **Handrails at Steps and Ramps** – Install handrails along access routes to the main entrance or offer an alternative accessible entrance.

☐ **Mandatory**: **Accessible Doors** – Ensure that doors are wide enough (≥ 850 mm) for wheelchair users, people carrying luggage, or parents with pushchairs.

☐ Accessible Parking

2. Horizontal and Vertical Circulation

☐ **Mandatory**: **Corridor and Passageway Width** – Corridors and passageways must be wide enough for free movement of all users (≥ 1500 mm) and allow wheelchair turning (turning space every 75 m).

☐ **Mandatory**: **Internal Door Width** – Internal doors must be easy to operate and at least **850 mm wide** to accommodate wheelchair users.

☐ **Mandatory**: **Handrails on Stairs, Steps, and Ramps** – Install handrails on all stairs, steps, and ramps.

☐ **Mandatory**: **Accessible Elevators** – Ensure elevators or vertical lifting platforms are accessible and provide access to all floors.

☐ **Mandatory**: **Emergency Routes and Equipment** – Provide accessible emergency routes and equipment (e.g., evacuation chairs) or an emergency strategy for evacuation assistance.

3. Use of Building Facilities

☐ **Mandatory**: **Electrically Operated Access Doors** – Install electrically operated access doors (push-button or motion-sensor activated) at key entry points.

☐ **Mandatory**: **Accessible Controls and Switches** – Ensure controls (e.g., door handles, taps, sockets) are easy to understand and located at accessible heights (900 mm - 1200 mm).

☐ **Mandatory**: **Drinking Water Taps** – Drinking water taps must be accessible to persons with disabilities, including wheelchair users (at least one per floor in regularly occupied areas).

4. Sanitary Facilities

☐ **Mandatory**: **Accessible Toilets** – Ensure at least one wheelchair-accessible toilet per floor, with assistance alarms and gender-neutral options.

☐ **Optional**: **Parent-Child Changing Facilities** – Provide gender-neutral changing facilities for parents with young children.

☐ **Mandatory**: **Accessible Showers and Changing Rooms** – Ensure showers, bathrooms, and changing rooms are accessible to people with physical disabilities, including wheelchair users.

5. Wayfinding

☐ **Mandatory**: **Clear Floor Plans** – Provide clear floor plans indicating entrances, sanitary facilities, and elevators.

☐ **Mandatory**: **Good Accessible Lighting for all PwDs** – Ensure good lighting conditions, especially at access points, entrances, stairs, and elevators.

☐ **Mandatory**: **Clear Signage** – Use clear, easy-to-understand signage that includes visual contrast, with availability in multiple languages where needed.

☐ **Mandatory**: **Visual Contrast and Color** – Implement visual contrast and color schemes to aid orientation, provide hazard warnings, and enhance the readability of information and signs.

☐ **Optional**: **Tactile Information** – Provide tactile information, including raised signage, Braille, tactile walking surface indicators (TWSI), and tactile maps or models.

☐ **Optional**: **Auditory Communication** – Include audible communication systems such as talking signs and announcement systems for key areas.

☐ **Optional**: **Use of Scents for Orientation** – Where applicable, consider using scents or aromas as additional orientation cues.

6. Supporting Technology(scope or not ?)

☐ **Mandatory**: **Hearing Amplification Systems** – Install hearing amplification systems (e.g., induction loops) at service desks, meeting rooms, performance spaces, and other public gathering areas.

☐ **Optional**: **Auditory Information Systems** – Implement auditory information systems for navigation within the building.

☐ **Mandatory**: **Visual Alarm Systems** – Install visual alarm systems for emergency situations.

☐ **Optional**: **Voice or Touchscreen Control Systems** – Provide voice or touchscreen control systems for key building functions.

7. Accessible Spaces

☐ **Mandatory**: **Accessible and Inclusive Sanitary Facilities** – Ensure accessible and inclusive sanitary facilities for all genders and ages.

☐ **Optional**: **Accessible Changing Rooms and Relaxation Areas** – Provide accessible changing rooms and relaxation areas along indoor and outdoor walking routes.

☐ **Optional**: **Space for Women to Express Milk** – Ensure privacy for women to express milk or breastfeed.