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Quantified photo-analysis for indoor and outdoor places of hybrid working. Location-specific approach

Aulikki Herneoja and Emilia Rönkkö
Faculty of Technology, Oulu School of Architecture, University of Oulu, Oulu, Finland

Annu Haapakangas
Finnish Institute of Occupational Health, Helsinki, Finland, and

Simo Hosio
Center for Ubiquitous Computing, Faculty of Information Technology and Electrical Engineering, University of Oulu, Oulu, Finland

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Abstract

Purpose – The purpose of this study is to support successful interdisciplinary research in understanding the leverage points between employee experience and the multitude of environmental factors. From a design knowledge perspective, the theoretical content is related to the environmental demands-resources model and Kaplan's attention restoration theory. Gibson's theory of affordances enlightens the latent action possibilities the environment offers individuals. The photo analysis originates from press photograph story analysis by Kedra and is customised to fit handling large quantities of photographs.

Design/methodology/approach – The increase in hybrid work has strengthened the trend towards using more flexible, space-efficient and non-territorial workplaces and other places not traditionally designed for work. Novel methods fitting interdisciplinary research are needed for analysing visual–spatial characteristics of the built work environment. This paper introduces a photo analysis method to advance understanding of workers' use of indoor and outdoor physical surroundings.

Findings – The proposed quantified photo-analysis method provides similar structuring and rating for both indoor and outdoor built environments. The three main categories are nature elements (sky, ice or snow, water, greenery), static elements (built environment) and dynamic elements (people, furniture and vehicles) visually present at the same location as the worker or are seen through a window view.

Originality/value – The proposed photo-analysis provides method to study three-dimensional physical hybrid work environments at organisations' properties and other places, which was not considered in earlier work environment research. The self-reported photos documenting workers' views at their workstations are material for analysing the built environment's affordances visually. Photo-analysis fits to machine vision analysis. The quantified visual data set is considered comparable or mergeable with the other quantified data sets produced by the participating disciplines to search for evidence of health – or well-being-related impacts.

Keywords Photo-analysis, Hybrid working, Physical work environment, Indoor, Outdoor, Interdisciplinary approach

Paper type Conceptual paper

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1. Introduction

Hybrid working has increased in workplaces after the COVID-19 pandemic. With hybrid work, we mean combining on-site work at the workplace and teleworking. By hybrid workplace, we refer to organisations now leading a larger variety of workers with different hybrid work profiles, ranging from no to full-time teleworking. The rise of hybrid work has changed the spatial practices of knowledge work, expanding the work environment beyond the office to homes, second homes, co-working spaces, third places and urban spaces in city centres, suburban housing areas. The rapid, unchecked growth of hybrid work has caused challenges, as many organisations are experiencing low office attendance. Currently, we do not know the favourite or least-liked places in activity-based offices, or where working takes place outside office spaces or how these conditions fit into work tasks or affect recovery from work. One of the challenges is that we lack methods to determine where and what kind of places hybrid work takes place. New methods are needed because researchers cannot personally observe all the places where work is done, as is possible in office spaces. We are particularly interested in determining, through the development of a photo analysis method, the types of places where employees work within the organisation's premises or in what kind of places they telework from outside the office. The photo analysis method is proposed as one additional part of the methodological palette for hybrid work environment research.

The increased spatial and temporal flexibility of hybrid work has also added complexity to indoor spaces and transitions between their locations together with working outdoors as a new phenomenon in work environment research. There is already some research on the phenomena of working outdoors and its effects on workers (e.g. Petersson Troije *et al.*, 2021; Söderlund *et al.*, 2023; Javan Abraham *et al.*, 2023; Bälter *et al.*, 2018). This line of research and the development of outdoor working is largely motivated by extensive evidence on the beneficial effects of contact with nature on well-being, work performance and health (Berto, 2014; Berman *et al.*, 2008; Gascon *et al.*, 2016; Markevych *et al.*, 2017). The visual elements of the natural environment appear to explain a part of the beneficial effects (Lee *et al.*, 2015; Lottrup *et al.*, 2013). However, studies on working outdoors have not yet investigated attributes of the outdoor environment through photographs. In addition to considering the outdoors as a "green" natural environment, researchers' interest in the "grey" built environment has risen (e.g. Stoltz and Grahn, 2021). In the context of the built environment, the difference between outdoor and semi-outdoor spaces requires clarification. In brief, the building envelope separates the conditioned indoor environment from the unconditioned outdoor environment (e.g. Cleveland and Morris, 2009; Syed, 2012). Semi-outdoor spaces do not exclude enclosed spaces which provide protection from the weather but lack stable thermal control indoors, including means of transport, or e.g. shopping malls and railway stations (e.g. Nakano and Tanabe, 2020). Outdoor space may be partially protected by walls or other parts of the building, and it may also be under the open sky or apart from any building. Open-sky outdoor space may be sheltered with light structures or provide other types of protection from the weather. With the concept of outdoors, we refer from now on to both outdoor and semi-outdoor environments Currently, the research reports of indoor work environments, at best, provide a furnished floor plan and a few photographs of space's general appearance. In interdisciplinary work environment research where architect design researchers are involved, we have found it necessary to find means to document hybrid workplaces more systematically, especially from the worker's perspective. For example, to study the linkages between the low presence rates at the office and the physical environment's deficiencies (Haapakangas *et al.*, 2024), it would be necessary to know what kinds of spaces are available and which of them the worker uses. Observations or analyses of the physical environment are possible to conduct on an organisation's premises since they

form a defined entity whose location is known. In hybrid work, the worker can also choose another place, public or private, located indoors or outdoors, which cannot be documented by the researcher because their locations are unknown. However, for the worker, the locations of work and the transitions between them form a whole. Visually documented hybrid work locations would be valuable in understanding the kind of environments workers are exposed to.

The development of photo analysis is related to a broader palette of methods, where the common denominator is the linking of time-location data to data sets (e.g. physiological data, short mobile-based enquiries, self-reported photographs) collected from the same participant. Analysing qualitative material, such as photographs, is laborious, even with small volumes; however, we aimed to process large volumes of photos to achieve credible evidence. Another obstacle was that the qualitative results of photo analysis are not comparable or combinable with quantitative data sets. In an interdisciplinary research context, it would be valuable to gain a comprehensive understanding of participants' exposure to their environment in different locations, comparing or merging data sets. Therefore, we are eager to develop a methodology to quantify qualitative content in a way that maintains its meaningfulness to architectural designers. In this article, we focus on presenting the development of the substance part of the photo analysis method, introducing the technological analysis process only to the extent necessary for understanding the substantive choices.

2. Theoretical contents in the hybrid work environment

The method of photo-analysis contributes to the environmental demands-resources (ED-R) model (Roskams and Haynes 2020), a domain-specific extension of the job demands-resources (JD-R) theory (Demerouti *et al.*, 2001; Bakker and Demerouti, 2018). The ED-R is meant as a standalone framework to represent the complex employee–workplace relationship. Broadly, the ED-R model (Roskams and Haynes, 2021) suggests that the provision of more effective workplaces relies on a combination of three broad strategies: the mitigation of environmental demands (e.g. creating silent working areas), the enhancement of environmental resources (e.g. placing interior plants within the office) and to facilitate the user-directed, bottom-up process of environmental crafting (e.g. implementing flexible working policies) (Roskams and Haynes, 2021). From a design point of view (e.g. architecture and interior design), the first and second strategies of ED-R would benefit from a design inventory of space informed by professional best practices, to be advanced by affordance-based evaluations (Bardenhagen and Rodiek, 2016). Affordance is not a characteristic of the environment, but it is also formed in the interaction between the individual's needs and perceptions and the environment (Gibson, 1979). Individuals use affordances to regulate their emotional balance, which manifests as positive effects of being in one's favourite place on well-being, for example. Korpela *et al.* (2008) The ED-R's enhancement of environmental resources will benefit from a close reading of attention restoration theory (ART) (Kaplan and Kaplan, 1989; Kaplan, 1995) from a design knowledge perspective, not reducing it to the green plants for restorative effects. Kaplan and Kaplan (1989) described a series of characteristics that an environment must have to provide a restorative experience, such as fascination, being away, extent (later using the extension) and compatibility. In this paper, we regard these restorative elements to see if the design knowledge perspective contributes further understanding when developing a photograph-based visual analysis method. The third strategic point of ED-R (the user-directed, bottom-up process of environmental crafting) is also a design matter. It is essential for designers to understand how environmental crafting is implemented in hybrid work and in places not

designed for work. Flexible working is closely linked to the hard-to-predict usage of the organisation's premises, setting novel challenges to spatial design, too. It is essential for designers to understand how environmental crafting is implemented in hybrid work and in places not designed for work. The development of novel methods for analysing the settings for indoor and outdoor knowledge work needs to be positioned into a broader theoretical framework. Scale is an essential aspect of architectural design and urban planning. Thus, we advocate for adopting a settings-based approach as a framework for analysing the features of environmental settings that become relevant in different areas of design, from micro-level workstations to macro-level urban structures. It reckons that place and spatial context are essential and modifiable determinants of health and wellbeing, which conjoins with the World Health Organization (WHO) healthy settings approach defined in the 1986 Ottawa Charter for Health Promotion. It also underlines the importance of addressing the contexts within which people live, work and play, as well as the needs and capacities of people to be found in different settings (Poland *et al.*, 2009).

Taking the environmental setting as a lens for analysis, we also wish to address some of the deficiencies related to multi-professional collaboration in health promotion. The need to reconnect public health and design disciplines and practices has been expressed clearly over the years (e.g. Corburn, 2004), but developing shared conceptual frameworks and applicable methodologies has become difficult. Recently, design practices have evolved towards nature-based solutions that seek to find synergies between urbanisation, human health and ecosystems (Roggema *et al.*, 2021). This is bounded by the recognition of urban natural (especially green and blue) spaces as health-promoting environments with the potential to protect health through a multitude of pathways and effects related to biodiversity (Aerts *et al.*, 2018; van den Bosch and Nieuwenhuijsen, 2017). While the scientific evidence of the health benefits of "green" spaces has been accumulating steadily over the years (WHO, 2016), there are gaps in translating the evidence related to the health benefits of "green" and "blue" exposure into information that is usable for architects and urban designers. Advancing the contextual understanding of the places of knowledge work serves the needs of planners to develop health-supportive settings in macro-level and create affordances that support work satisfaction. The methodological development with quantified photo analysis aims to renew designers' toolkits to understand better the micro-level interaction dynamics between health-supportive settings and individual preferences. It also supplements the existing methodology for analysing urban green areas through satellite images (Puhakka *et al.*, 2020), field studies or self-assessments (WHO, 2016).

3. Method

In this paper, we focus on analysis-method for workers' self-reported photos of indoor and outdoor hybrid work environments. The presumption is that workers may autonomously choose a location, place and workstation to work. We focus equally on indoor and outdoor spaces, because of the transitions between home and workplace or between different work locations form a whole to the employee. Indoors, we also include the window view (from inside out) since it is also an integral part of the employee's visual experience. Initially, we developed photo analysis (PPSA-OKW2) for outdoor knowledge working environments to be able to advance our understanding of outdoors and semi-outdoors in the context of hybrid working (Herneoja *et al.*, 2023). The present version now under discussion is called quantified photo analysis for places of hybrid work (QPA-HW).

3.1 Background: methodological conditions

We set the following conditions for the photo-analysis methodology. *Firstly*, it was necessary, that photographs would be taken by the workers themselves either at company

premises or when working hybrid. It would be beneficial if, when submitting a photo, the occupant could answer a short multiple-choice questionnaire about the job task and situation. *Secondly*, we aim to include the photos the shoot time and coordinates, i.e. the time-location specific data, where and when the hybrid work took place and was documented (by photographing it), for further studies of the place's qualities and conditions. Another, but as important reason for location data is to compare or merge photo analysis data with other data sets that share the same location data from the same occupant. *Thirdly*, we aim to analyse large numbers of photographs so that our data are of the same size as the data sets with which we intend to compare or combine it in interdisciplinary research. *Fourthly*, we aim to quantify the qualitative content of the photographs to support the comparison or merging with other data set from other disciplines. Quantification would be applied during the analysis process and the form of results. *Fifthly*, quantified photo analysis is not intended to be used in isolation from other location-based methods used across disciplines (e.g. experience sampling or stress- related data such as heart rate variability collected using wearable devices from the same participants, including time-location tracking data), as identifying accumulated factors (demands or resources) across data sets can provide stronger evidence-based information.

The mobile-based experience sampling method (ESM) enabled us to fulfil the *first condition* of self-reported photographs, along with the short questionnaire, and the *second condition* of including time-location-specific data in the photos. The ESM was developed in the late 1970s and further refined to report events using electronic pagers, which notified them to fill out self- report diaries (Hektner, 2007; Larson and Csikszentmihalyi, 1978). ESM enables the collection of a representative sampling of the context and the immediate experiences in one's daily life in a natural environment (Beal, 2015; Hektner, 2007). In our case, context refers to the place where the occupants have taken photograph when working, and the immediate reaction refers to the nature of the job task and whether the chosen location supports this job task. Mobile technologies enable both signal prompting and data collection, for example, by using smartphones (Pejovic *et al.*, 2016; van Berkel *et al.*, 2017). Time-location data is included in mobile data collection by default if the occupant has given their consent to tracking. The AI-based machine vision (MV) analysis approach supports our *third condition* by enabling to automate labour-intensive workflows (e.g. Starzyńska-Grześ *et al.*, 2023) for identifying the chosen elements from the photographs. The MV will apply deep learning libraries (e.g. TensorFlow, PyTorch) to analyse photographs submitted by workers, detecting set objects, activities and environmental features. MV analysis also supports our *fourth condition*, which was the quantification of the photographs' qualitative content. Our substance-wise choices guide the quantification, i.e. what aspects are analysed in the photographs. We focus on reporting and justifying the substance for what to analyse in the quantified photo-analysis, and we leave the detailed explanation of how the existing technical methodologies for collecting data and their AI-based analysis (MV analysis) are customised for hybrid work environment analysis purposes to the forthcoming paper. The methods described in *the first four conditions* are established methods in use, but to our knowledge, the MV analysis method of photographs or the quantification of photographs have not been applied in photo analyses dealing with hybrid work environments. The *fifth condition* may be tested in collaboration with work environment researchers from different disciplines who are willing to incorporate spatial data collection into their field-specific research methods and to compare or merge collected data sets. Usually, such collaboration is best achieved within the framework of joint research projects, but we have not yet been able to test this method in practice.

3.2 *Photo analysis method*

Photo analysis is a qualitative research method that enables an increase in overall understanding, in this case, of the quality, characteristics and meanings of places people prefer to use as voluntarily chosen locations for hybrid work, both indoors and outdoors. The potential of photographic methods in this research topic has been identified (Florin and Lehtinen-Jacks, 2022), although their use in studies dealing with hybrid working is limited. In this study, we broaden the outdoor knowledge work purposes customised press photograph story analysis (PPSA)-pOKW2 model (Herneoja *et al.*, 2023) originally based on Kedra's (2013PPSA [and PPSA-pOKW, predecessor of PPSA-pOKW2 (Herneoja *et al.*, 2022)] to be applicable for indoor and outdoor to fulfil the needs to study places of hybrid work. The present version to be introduced is called QPA-HW.

The photo reportage-type journalistic images, of which PPSA (Kedra, 2013) is based on, are classified: content, context, layout, number of photographs and dominant function (Wolny-Zmorzyński, 2010, 2010; Kedra, 2016). In QPA-HW (and its predecessors) we focus on the contents of the photograph, since the other features were referring to press article's context, layout of the article, number of photos in the article and the dominant functions of the press article in general. In the original criteria of PPSA, the content was defined as everyday life situations, but we focus on photographs of places designed or used for hybrid work, but other criteria for classification remained as in the original model (Kedra, 2016). In PPSA-pOKW2 (the earlier version of QPA-HW), we proposed five visual elements of a setting (contents): vegetation, built environment, other people, traffic and vehicles and natural light. Although the perception of natural and electric lighting (illumination) and preventing glare are essential for the worker, they seemed too abstract for photographic analysis; therefore, they were excluded from the elements to be analysed. The used concepts were also clarified. Vegetation seemed too narrow as a concept, as it is only one of the elements related to nature. Therefore, we included water and its winter forms, ice and snow, as well as the sky, which can also be related to natural light. All the other four visual elements were kept by adjusting (simplifying) how they were called. In this paper, we use eight elements (contents), divided into three categories, in a photographic analysis of both indoor and outdoor work environments (Figure 1): Category 1, *nature elements* (sky, greenery, water and ice or snow); Category 2, *static elements* (built environment); and Category 3, *dynamic elements* (people, vehicles and furniture). Analysing indoor and outdoor workplaces with similar structuring would not only advance understanding of what kind of places hybrid working takes place but also add to the range of methods used in interdisciplinary research.

Photographs are considered a form of visual communication; therefore, we applied the PPSA framework (Kedra, 2013), which includes the elements of sender, message, code, context, contact and receiver. These components were divided into thematic sections accordingly (Kedra, 2013): denotation (denotation-sender, denotation-message and context, denotation-receiver), connotation (connotation-sender, connotation-message and code, connotation-receiver) and additional questions. Kedra (2013) refers to Barthes (1977) to explain the concept of code: the image is not reality, but at least it is a perfect *analogon*, and

Context / Category	Nature elements (1)	Static elements (2)	Dynamic elements (3)
Indoors	Greenery	Architectural envelope	People and furniture (Interior orchestration)
Window view	Sky, greenery, water and ice or snow	Built environment	People, vehicles and furniture
Outdoors	Sky, greenery, water and ice or snow	Built environment	People, vehicles and furniture

Figure 1. Summary of the eight visual elements' division into three categories and contexts
Source: Authors' own work

therefore (in the PPSA model), the denotative part serves as an *analogon*. In the MV analysis the features of the *analogon* (denotation) would be identified mechanically as we have indicated. AI-assisted MV analysis does not make interpretations; instead, researchers make the necessary interpretations based on the data, e.g. by using its time-location-specific data and other associated data sets to recognise field-specific features. In Kedra's (2013) PPSA model, the connotative part is a sign that requires an interpretant, the receiver, since the photographic code provides the receiver's intertextual connotations. According to Barrett (2006), we form meaningful connections between what we see and experience in a photograph and what we have seen and experienced previously. Figure 2. illustrates the visual communication of photographs based on Kedra's (2013) original structuring of denotation-connotation-additional, modified to fit the topic of hybrid work (QPA-HW model).

The additional question in the original PPSA model (Kedra, 2013) was developed for the learning process purposes but also to provide a summary for the analysis. The additional question was also encouraged to be formulated according to the specific research topic. In the QPA-HW model, the additional question (Figure 2) was rephrased to form, What theme does the photograph story, supported by time-location-specific data, communicate about the demands or resources the occupant is exposed to when working hybrid?

3.3 Element categories of the analysis: nature, static and dynamic elements

Nature elements outdoors. "Green" or *Greenery (G)* as we call it in the photo analysis, will be understood as plants in different scales (e.g. trees, shrubs, climbers, lawns, perennials and summer flowers) extending the appearance of the "green" to all seasons (e.g. evergreens and tree branches with or without green foliage). Greenery also includes stones and rocks, as part of landscaping and therefore we did not see the need to separate them into their own category. The photo analysis will not be limited to seasonal representations of "green" but also the other natural elements visible in the urban or rural built environment, such as *Water (W)* ("blue"), *Ice or snow (I)* ("white") and *Sky (S)* ("the other blue"), will be included as connotations to or part of nature. When regarding nature benefits of "blue", it is often considered environmentally dominant by calling it the blue space (e.g. the marine environment or other giant water bodies), but smaller urban blue elements (e.g. rivers,

Self-reported photos (ESM) to be analysed in the QPA-HW model		
Denotation-sender	**Denotation-message & context**	**Denotation-receiver**
The photographer is the identified occupant. Time and location where the photograph were taken is known if the occupant give consent for tracking.	Self-reported photo/-s (ESM) by occupant (view when raising one's gaze from the screen, and towards window-view, if available) together with answers to max. 5-7 multiple-choice (four step scale) questions: *location of place* (at office or out of office), *job-task at hand*, *job task–place fit*, and *opinion of the place*.	MV analysis. Percentages of Nature elements, Static and/or Dynamic elements in detail detected from the photograph. Categorisation of the photographs based on combinations of the visual elements.
Connotation-sender	**Connotation-sender & code**	**Connotation-receiver**
In hybrid work, the participant can (to some extent) choose their workstation (at the office) or work location (out of the office). The content of the photograph can (at least to some extent) be thought to communicate the participant's preferences for the chosen place.	Occupant's answers to questions about "job task–place fit" and "opinion of the place" relate to one's previous experiences of similar situations. *Location of place* (at office or out of office) provides additional information if occupant have not given consent for tracking. *Job-task at hand* provides baseline info to researchers.	Based on the outcome of the MV analysis and the following categorisation, the photographs are preliminarily quantified according to the set principles (Fig. 19 & 20).
Additional questions		
What does the photograph story communicate about the demands or resources the occupant is exposed to when working hybrid?		
Note: When other time-location-related datasets collected from the occupant are combined with the information obtained through the photograph, a more comprehensive understanding of the impact of location on the occupant is obtained.		

Figure 2. The table follows the structuring of denotation-connotation-additional questions as the original press photograph story analysis (PPSA) by Kedra (2013), but the themes were modified to fit the topic of hybrid work (QPA-HW model). The table structuring is by Kedra (2013), but the content is modified by the authors

Source: Authors' own work

creeks, ponds) are relatively neglected (e.g. Luo *et al.*, 2021). We will include in our analysis even the more minor water features, such as water mirrors or fountains within the built environment. The "white" in the winterly urban park context has been shown to have restorative effects (Bao *et al.*, 2023). We will include the "white" in our photo analysis in places of the built environment without any greenery to find out whether ice or snow without covered vegetation (e.g. evergreens or branches lacking foliage) have similar effects in a snowy nature-landscape environment. The role of the sky, "the other blue", has been explicitly investigated in the perception of nature (Sztuka *et al.*, 2022) and as part of the window view and source of natural light in high-density urban settings (Masoudinejad and Hartig, 2020), receiving preliminary positive outcomes of its restorative effects. The role of the sky as one of the nature elements will be interesting to study since it is not a location- or geography-dependent element but is present everywhere. We will include the sky as one of the Nature elements to be analysed from the photographs. *Nature elements indoors*. In window views, all the Nature elements are visible and may be included in the indoor photo analysis. In indoor views (not including window view), most likely only *greenery* (e.g. living, mummified (embalmed) or silk (artificial) plants) is included in this category of Natural elements.

Static elements outdoors. "Grey" in the photo analysis will be understood as the *built environment (B)* in different scales, from city spaces (e.g. street views, allies, plazas or squares), semi-outdoor public spaces (e.g. sheltering structures, shopping malls) to close-up photos of aforementioned contents (e.g. part of buildings, their structures or surface materials, including materials on the ground, such as asphalt and other pavement materials e.g. concrete and natural stones, gravel and stone ash). The studies about the restorative effects of the built environment are few (Maffei *et al.*, 2023) and instead, it has been considered opposite to unbuilt, to nature and its elements. The dichotomy is no longer obvious when interest has arisen in the possible beneficial well-being effects of the built environment (e.g. Stoltz and Grahn, 2021). In any case, the built environment is present to some extent in hybrid-workers' daily routines, forming stationary background settings for hybrid work and during the transitions. *Static elements indoors*. All outdoor Static elements could also be seen through a window view. Indoor views have Static elements of their own (e.g. floors, walls and ceilings that form the inside spaces), which may be considered a continuum of the (outdoor) built environment. In general, the major difference is that indoor environmental quality is stable (IEQ; BS ISO 17772-1, 2017), unlike outdoor and semi-outdoor places where it is unstable (e.g. Nakano and Tanabe, 2020). In our photo analysis, we enlarge the static elements to include both the built environment outdoors and the indoor built elements also called an *architectural envelope* (including the fixed technical systems) (Herneoja *et al.*, 2022), similar to the more broadly used building envelope (e.g. Cleveland and Morris, 2009). The architectural envelope is not limited to the outside walls but may also include other fixed bordering structures around working areas, such as drywalls or movable wall structures.

Dynamic elements outdoors. The photo analysis considers vehicles, people and chairs (as the possible presence of people). *Vehicles (V)*, means of public and private transportation, motorbikes, bicycles (manual or motorised), scooters and other micromobility devices will be considered in the analysis in several ways. Vehicles, as either still or moving elements in the scenery, are sources of noise or visual distraction. Vehicles may also have a positive link to the affordance of transportation. Public or private transport as a place of work, when in motion (e.g. inside a means of public transport or in private transport not driving) or when stationary (e.g. charging one's electric car; waiting for someone). The other *people (P)* visible in the photographs may be considered positive features as possibilities for social

contact. Other people may be considered also as a cause of adverse effects, such as visual (e.g. moving around) or auditory (e.g. talking or causing another type of noise) distractions. *Furniture (F)* referring to seats (e.g. on terraces, private or semi-private courtyards, fixed chairs or benches at public parks or shopping malls) is considered in the photo analysis as affordance of seating, a possibility for other people to be in the view (very close or farther). The worker may have knowingly chosen a place where other people might make social contact or at least not feel distracted by the presence of other people. *Dynamic elements indoors*. In the dynamic elements category, in the indoor window view, vehicles are considered only as parked or moving objects (not including their inside spaces since they belong to semi-outdoor context), as possible sources of noise or visual distraction. Similarly, as outdoors also in an indoor context (in indoor view), *people* visible in the photographs may be considered positive features as possibilities for social contact. Other people may as well be considered as a cause of adverse effects, such as visual (e.g. moving around) or auditory (e.g. talking or causing another type of noise) distractions. In window view, especially when indoor working environments are at street level, bypassing people may be a source of visual distraction. Also, indoors, *furniture* is considered as an affordance for hosting workers' activities, a possibility for other people to be in the view (very close or farther). The worker may have knowingly chosen a place where other people might make social contact or at least not feel distracted by the presence of other people. In general, indoor work environments, interior design (e.g. furniture, non-fixed lighting fixtures, acoustic solutions and textiles) is designed to facilitate employees' activities in office spaces to support their working and recovery during the workday [i.e. *interior orchestration* (Herneoja *et al.*, 2022)]. Regarding bordering the worker's view, a large screen (a work tool on a desk) is comparable to an acoustic panel attached to the front edge of a desk. Although it does not improve acoustics or add colour or a material feel to the workspace, it does affect the bordering of the worker's view. Therefore, we also include large desk screens in the category of indoor dynamic elements. Indoors, in office buildings, there are also places that are not designed for working, such as coffee or lunch canteens, which may be available (and inviting) outside the times used for their primary functions. In hybrid work, when teleworking, not all spaces are most likely designed as workplaces (e.g. at homes, cafes, holiday homes). As outdoors also in indoor spaces, furniture is an affordance for other people to be in view either as a source of social contact or a source of visual or auditory distraction.

4. Combinations of the visual elements

All photographs will be divided into seven main groups (MG) by the category-based division into *nature*, *static* and *dynamic element* categories. In the MG 1–3, each photo has visual elements from only one category (one visual element or all of them) (Figure 3). Each category's visual elements would first be studied separately. Photographs with only one nature element (Category 1), two-, three- and all four-element combinations would be analysed separately. Similarly, static (Category 2) and dynamic (Category 3) elements would be analysed separately. These found one-category-based combinations would then be

MG	Visual elements from one category	Total %
1.	Cat. 1. Nature: Sky (S), Greenery (G), Water (W) and/or Ice or snow (I)	100%
2.	Cat. 2. Static: Built: Built Environment (B)	100%
3.	Cat. 3. Dynamic: Vehicles (V), People (P) and/or Chairs (C)	100%

Figure 3. Group 1–3 photographs have elements from only one category
Source: Authors' own work

combined with visual elements from another category, creating the MG 4–6 (Figure 4) and combinations from all three categories, creating the MG 7 (Figure 5).

Within the settings-based framework, the *urban*, *suburban*, *rural* and *nature scenarios* are formed to contextualise indicative settings where photographs are from, if coordinates are known, or presumably could belong if location data is not provided. This division indicatively adapts Eurostat's urban-rural typology classification targeted to urban design and planning purposes, which is based on three categories: predominantly urban regions, intermediate regions and predominantly rural regions. Our scenario-based approach is relevant, especially for photos with wider outdoor or window views, where two- and three-category combinations are most likely to occur. Urban scenario (predominantly urban region, Eurostat) refers to an urban area is the region surrounding a city (Urban Area, 2024). We also include the city itself in our urban scenario since cities are often the (main) working area for knowledge workers. Generally, urban areas are very developed, meaning human structures, such as houses, commercial buildings, roads, bridges and railways, are dense (Urban Area, 2024). Suburban scenario (intermediate region, Eurostat) refers to a suburban area, a residential district located on the outskirts of a city (Suburban Area, 2024). They may also be part of a city or urban area or exist as separate residential communities within commuting distance of a city. They serve as the residential area for much of the city's workforce. Suburbs usually have more parks and open spaces. Most suburbs are less densely populated than cities (Urban Area, 2024). Rural scenario (predominantly rural region, Eurostat, 2026) refers to a rural area, an open swath of land with few homes or other buildings and few people. A rural area's population density is very low (Rural Area, 2024). Nature scenario refers to a natural area, a geographical area of its own or as in a city having a physical and cultural individuality developed through natural growth rather than design or planning (Natural Area, 2024). In city areas also large parks are included in out photo analysis to the nature scenario. Identifying the context of the photos without location information (coordinates) is most likely challenging, especially with close-up images. For example, photos containing only greenery might have been taken in urban settings or, on the other hand, only built environment features containing photos might have been taken in rural settings.

4.1 One-category combination

Nature elements. Outdoor photographs with only one type of nature element (Figures 3 and 6) are probably rare. Some close-up images might have only greenery (e.g. being in a garden) or only sky (e.g. if working in a recliner (chair), leaning back when raising one's gaze in an open place and/or high-up). To be able to look at only water would be quite tricky since the person should look down when raising one's gaze from the screen. To see

MG	Visual elements from two categories		Total %
4.	Cat. 1. Nature: Sky (S), Greenery (G), Water (W) and Ice or snow (I), xx%	Cat. 2. Static: Built: Built Environment (B), xx%	100%
5.	Cat. 1. Nature: Sky (S), Greenery (G), Water (W) and Ice or snow (I), xx%	Cat. 3. Dynamic: Vehicles (V), People (P) and Chairs (C), xx%	100%
6.	Cat. 2. Static: Built Environment (B), xx%	Cat. 3. Dynamic: Vehicles (V), People (P) and Chairs (C), xx%	100%

Figure 4. Group 4–6 photographs have elements from two categories
Source: Authors' own work

MG	Visual elements from three categories			Total %
7.	Cat. 1. Nature element, xx%	Cat. 2. Static, xx%	Cat. 3. Dynamic, xx%	100%

Figure 5. Group 7 photographs have elements from all three categories
Source: Authors' own work

No	Category 1, Nature, one element	Total %
1.1.(1-4).	Sky (S), Greenery (G), Water (W), or (Ice or snow) (I), 100%	100%

Figure 6. Each photograph has only one type of natural element: sky (s), greenery (G), water (W) or (ice or snow) (I)
Source: Authors' own work

only snow would be possible if a person is e.g. facing the upper slope. Presumably, in photos with only two nature elements (Figure 7), one element is greenery. The presence of the sky or water in the photographs is particularly interesting since they, as restorative elements, have been studied very little. Unlike the water element, the sky's visibility does not depend on the geographic location. The visual presence of ice or snow as a possible restorative element is presumably relevant in Nordic countries where people are familiar with cold climates and have experiences with winter (e.g. winter outdoor activities). The combination "water – ice or snow" is probably rare, as it only occurs in winter on flowing water bodies and during the changing seasons. Images with three (Figure 8) or all four (Figure 9) nature elements presumably highlight the diverse natural environments in which hybrid work takes place.

Indoors photographs with only one type of Nature element are probably rare (Figure 3). Some indoor images with close-up views might have only greenery if a worker is seated right

No	Category 1, Nature, two-element combinations		Total %
1.2.(1-6).1	(S), (G), or (W), 1<X<25%	Greenery (G), Water (W), or (Ice or snow), X<99%	100%
1.2.(1-6).2	Sky (S), Greenery (G), or Water (W), X<60%	Greenery (G), Water (W), or (Ice or snow), X<60%	100%
1.2.(1-6).3	Sky (S), Greenery (G), or Water (W) X<99%%	(G), (I) or (W) 1<X<25%	100%

Figure 7. In sub-groups 1.2.(1-6).1–1.2.(1-6).3, each photograph has two types of natural elements. Each two-element combination is set in three different percentage-based proportion categories. The two-element combinations would be: sky – greenery, sky – water, sky – (ice or snow), greenery – water, greenery – (ice or snow) and water – (ice or snow)
Source: Authors' own work

No	Category 1, Nature, three-element combinations			Total %
1.3.(1.-3).1	(S), (G), or (W), 1<X<25%	(G), (W), or (I), 25<X<40%	Water (W), Ice or snow (I), or Sky (S), 40<X<60%	100%
1.3.(1.-3(.2	(S), (G), or (W), 25<X<40%	(G), (W), or (I), 25<X<40%	(W), (I), or (S), 25<X<40%	100%
1.3.(1.-3).3	Sky (S), Greenery (G) or Water (W) 40<X<60%	Greenery (G), Water (W), or (I) 25<X<40%	(W), (I), or (S), 1<X<25%	100%

Figure 8. In sub-groups 1.3.(1-3).1–1.3.(1-3).3, each photograph has three types of natural elements. Each three-element combination is set in three different percentage-based proportion categories. The three-element combinations would be sky – greenery – water, greenery – water – (ice or snow) and water – (ice or snow) – sky
Source: Authors' own work

No	Category 1, Nature, four-element combinations					Total %
1.4.1.1	Sky (S), 20<X<30%	Greenery (G), 20<X<30%	Water (W), 20<X<30%	Ice or Snow (I), 20<X<30%		100%
1.4.1.2	Sky (S), 10<X<20%	(G), 10<X<20%	(W), 10<X<20%	Ice or Snow (I), 40<X<60%		100%
1.4.1.3	Sky (S), 10<X<20%	(G), 10<X<20%	Water (W), 40<X<60%		(I), 10<X<20%	100%
1.4.1.4	Sky (S), 10<X<20%	Greenery (G), 40<X<60%		(W), 10<X<20%	(I), 10<X<20%	100%
1.4.1.5	Sky (S), 40<X<60%		(G), 10<X<20%	(W), 10<X<20%	(I), 10<X<20%	100%

Figure 9. In sub-groups 1.4.1.1–1.4.1.5, each photograph has all four types of natural elements. These four-element combinations are set in five different percentage-based proportion groups. In sub-group 1.4.1.1, the proportions of all four elements are approximately the same. In the four other sub-groups (1.4.1.2–1.4.1.5), one of the visual elements is always dominant
Source: Authors' own work

in front of a green wall composed of vegetation (or similar). *In window views* (from inside out), only greenery could be seen if a tree is very close to the façade or if a climber is growing on a façade in front of a window. In the window view, the sky could be the only nature element if a window is placed high enough with open view. These features could raise "soft" fascination: clouds, snow patterns and the motion of the leaves in the breeze (Kaplan, 1995).

Static elements. Outdoor photographs with only one type of static element (Figure 3) presumably focus on the built environment. These photos are most likely close-ups of an opposite wall, a view of a narrow alley, or a small, closed urban courtyard surrounded by multi-story buildings. The analysis of these photos will likely focus on the context type (urban, suburban, rural) and the visible materials and textures. *Indoors photographs* with only one type of static elements are either parts of the architectural envelope or parts of the built environment in the window view. Most likely, these photos are images with a close-up view of an opposite indoor wall, or in a window view similar as described above in connection with outdoor photos. Indoors, a close-up view of a white-painted drywall surface probably does not have any restorative characters raising a "sense of being away [or] compatibility with the environment" (Kaplan, 1995) as (e.g.) a wooden or brick material could bring about (in indoor or window view). A wider view, such as a *window view* to an alley or a courtyard space with interesting façade composition or use of material and textures, could arouse "extension; feeling of being able to travel through the environment in order to look for the information it provides" (Kaplan, 1995).

Dynamic elements. Outdoor photographs with only one type of dynamic element (Figures 3 and 10) are probably rare since elements from another category might also be visible. Photos consisting only of vehicles could be taken in a car at a parking lot (e.g. while waiting for someone and browsing emails). Photos of only people present could be taken in a crowded shopping mall, train station's bustle or similar urban place while sitting on a bench (e.g. when checking emails from a mobile phone). Photos with visible chairs could be taken in an empty café or restaurant terrace (e.g. stepping aside to scroll through e-mails). In the sub-group having two-element combinations (Figure 11), vehicle-people combinations could be seen in a parking lot with bypassing people, vehicle-chairs combinations on an urban empty terrace and people–chair combination in a crowded or half-crowded café or restaurant terrace. The sub-group having all three-element combinations (Figure 12) could belong to many various kinds of vibrant city life scenery.

Indoor photographs with only one type of dynamic element (Figures 3 and 10), which would most likely be a close-up view of furniture. For example, if the occupant is seated in a pod or in front of a table having an acoustic partitioning element (e.g. standing on the floor) or an acoustic panel (e.g. fixed on the side of the table in the panel is high enough) in front of

No	Category 3, Dynamic elements, one element	Total %
3.1.(1-3).	Vehicles (V), People (P), Furniture (F), 100%	100%

Figure 10. Each photograph has only one type of dynamic element
Source: Authors' own work

No	Category 3, Dynamic elements, two-element combinations		Total %
3.2.(1-3).1	(V), or (P), 1<X<25%	People (P), or Furniture (F), X<99%	100%
3.2.(1-3).2	Vehicles (V), or People (P), X<60%	People (P), or Furniture (F), X<60%	100%
3.2.(1-3).3	Vehicles (V), or People (P), X<99%%	(P), or (F), 1<X<25%	100%

Figure 11. In sub-groups "3.2.(1-3).1 – 3.2(1-3).3 the two-element combinations would be: vehicles – people, vehicles – furniture and people – furniture
Source: Authors' own work

No	Category 3, Dynamic elements, three-element combinations			Total %
3.3.1.1	Vehicles (V), 1<X<25%	People (P), 25<X<40%	Furniture (F), 40<X<60%	100%
3.3.1.2	Vehicles (V), 25<X<40%	People (P) 25<X<40%	Furniture (F), 25<X<40%	100%
3.3.1.3	Vehicles (V), 40<X<60%	People (P), 25<X<40%	Furniture (F), 1<X<25%	100%

Figure 12. In sub-groups 3.3.1.1–3.3.1.3, each photograph has three types of dynamic elements. Each three-element combination is set in three different percentage-based proportion categories
Source: Authors' own work

them, the view might be 100% furniture (e.g. the textile surface of an upholstered acoustic panel). At least at first, it is difficult to imagine what restorative features this type of furniture could have in close-up view. Of course, the textile surface's feel of materiality, pattern or colour can evoke "a sense of compatibility with the environment" (Kaplan, 1995).

In window views, it is not likely to have only vehicles, people or furniture visible other than if cars are parked, furniture is placed or people are walking in front of the window and the workspace is below the street level.

4.2 Two- and three-category combinations

Outdoor photographs with two- and three-category combinations seem most likely to occur in urban, suburban and rural scenarios. The one-category variations of nature and dynamic elements are used when combining them with static i.e. built environment elements or with each other. Forming these two- and three-category combinations is not only a mechanical procedure since adding categories enables broader angles in photographs. For example, the sky-built combination (4.2.1.1, Figure 13) could be a rooftop landscape seen from a roof terrace, where the only nature element is the sky. On the other hand, the same combination and percentages could also include photographs taken in a tight urban courtyard's balcony (e.g. when lifting one's gaze upwards from a laptop screen).

Indoor photographs with combinations of several categories, a wider angle of view is more likely than with visual elements of one category. In combinations of elements of two or three categories, interior views and window views have been examined as separate entities. However, it is possible, even likely (or at least desirable), that a window view is also visible, especially in wider interior views where a sense of depth is present. A wider view could evoke a sense of extension if the view would have "connection/-s between each element found in an environment" (Kaplan, 1995). The wider view also includes the possibility of dynamic elements, the other people entering the view, causing visual or auditory distraction.

Window view photographs with two- and three-category combinations seem most likely to occur in urban, suburban and rural scenarios. The one-category variations (Figure 3) of nature elements and dynamic elements are used when combining them with Static elements (Figure 4) or with each other (Figure 5). Forming these two- and three-category

No	Two-category Combination: Nature and Static environment elements		Total %
4.2.(1-4.)1.	S or G or W or I, 1<X<25%	Static elements (Cat. 2), X<99%	100%
4.2.(1-4.)2.	Sky (Sky) or Greenery (G) or Water (W) or Ice or snow (I), X<60%	Static elements (Cat. 2), X<60%	100%
4.2.(1-4.)3.	Sky (S) or Greenery (G) or Water (W) or Ice or snow (I), X<90%	Static (Cat. 2), 10<X<25%	100%
4.2.(1-4.)4.	Sky (S) or Greenery (G) or Water (W) or Ice or snow (I), X<99%	Stat <10%	100%

Figure 13. Most likely, in the urban scenario, the built environment elements dominate (4.2.(1-4).1); in the suburban scenario, the nature and built environment elements are approximately in balance (4.2.(1-4).2); in the rural scenario, the nature elements have dominance over the built (4.2.(1-4).3); and the nature scenario may contain only very small amounts of built environment elements (4.2.(1-4).4)
Source: Authors' own work

combinations is not only mechanical since adding categories leads to wider angles and views in photographs' contents.

4.2.1 Scenario-based structuring: outdoor and window-views. Urban scenario. The photographs with only visual static elements of the built environment (Figure 3) most likely belong to the urban scenario (Figure 14). Also, these static elements coupled with dynamic elements (Figure 4) with its sub-categories (Figure 15) reflecting city life belong evidently to the urban scenario regardless of which one of these two (static or dynamic) is the dominant one. The static, built environment's elements, coupled with nature elements (Figure 4), also most likely belong to the urban scenario, especially when the static elements are dominant as in the sub-category 4.2.(1–4.)1 (Figure 13). Also, the dynamic elements as indicators of vibrant city life, either alone (Figure 3) or coupled with nature elements (Figure 4), also most likely belong to the urban scenario, especially when the dynamic elements are dominant as in the sub-group 5.2.(1–7.)1 (Figure 16). The three-element combinations, nature–static–dynamic elements, could easily represent urban environments, especially when the Nature elements are in a minor position as in the sub-group 7.3.(1–8.)1 (Figure 17). However, the low percentage of nature elements in the urban scenario is a vague indicator since, in limited views, it might cover the whole image area.

No	Two-category Combination: Nature and Dynamic elements		Total %
5.2.(1-7.)1	Nature (Cat. 1), 1<X<25%	Dynamic elements (Cat. 3), X<99%	100%
5.2.(1-7.)2	Nature (Cat. 1), X<60%	Dynamic elements (Cat. 3), X<60%	100%
5.2.(1-7.)3	Nature (Cat. 1), X<90%	Dynamic elements (Cat. 3), 10<X<25%	100%
5.2.(1-7.)4	Nature (Cat. 1), X<99%	Dyn<10%	100%

Figure 14. Most likely, in the urban scenario, the dynamic elements dominate (5.2.(1–7).1); in the suburban scenario, the nature and dynamic elements could at most be approximately in balance (5.2.(1–7).2); in the rural scenario, the nature elements have dominance over the Dynamic (5.2.(1–7).3); and the nature scenario may contain only very small amounts of dynamic elements (5.2.(1–7).4.)
Source: Authors' own work

No	Two-category Combination: Static and Dynamic elements		Total %
6.2.(1-4.)1.	Static (Cat. 2), 1<X<25%	Dynamic elements (Cat. 3), X<99%	100%
6.2.(1-4.)2.	Static elements (Cat. 2), X<60%	Dynamic elements (Cat. 3), X<60%	100%
6.2.(1-4.)3.	Static elements (Cat. 2), X<99%	Dynamic (Cat. 3), 1<X<25%	100%

Figure 15. The built environment and the dynamic elements belong to the urban scenario regardless of their mutual percentages. It is less likely in the suburban scenario that only the built environment and dynamic elements are visible. Most likely, it would be rare to have these elements in the rural scenario and in the natural scenario, they do not belong at all
Source: Authors' own work

No	Three-category Combination: Nature, Static and Dynamic elements		Total %
7.3.(1-8.)1.	Nature (Cat. 1), 1<X<25%	(Static (Cat. 2), X% + Dynamic (Cat. 3), Y%) < 99%	100%
7.3.(1-8.)2.	Nature (Cat. 1), X<60%	(Static (Cat. 2), X% + Dynamic (Cat. 3), Y%) < 60%	100%
7.3.(1-8.)3.	Nature (Cat. 1), X<90%	10 < (X% + Y%) < 25%	100%
7.3.(1-8.)4.	Nature (Cat. 1), X<99%	X+Y<10%	100%

Figure 16. Most likely, in the urban scenario, the built environment and dynamic elements dominate (7.3.(1–8).1); in the suburban scenario, the nature elements and the sum of built environment and dynamic elements are approximately in balance (7.3.(1–8).2); in the rural scenario, the nature elements have dominance over the build and dynamic elements (7.3.(1–8).3); and the nature scenario may contain only very small amounts of built environment and dynamic elements (7.3.(1–8).4.)
Source: Authors' own work

MG	Visual elements from one category	Total %
2.	Cat. 2. Static: Built Environment (B)	100%
3.	Cat. 3. Dynamic: Vehicles (V), People (P) and/or Chairs (C)	100%

No	Two-category Combination: Nature and Built environment elements		Total %
4.2.(1-4.)1.	S or G or W or I, 1<X<25%	Static (Cat. 2), X<99%	100%

No	Two-category Combination: Nature and Dynamic elements		Total %
5.2.(1-7.)1	Nature (Cat. 1), 1<X<25%	Dynamic (Cat. 3), X<99%	100%

No	Two-category Combination: Built environment and Dynamic elements		Total %
6.2.(1-4.)1.	Static (Cat. 2), 1<X<25%	Dynamic (Cat. 3), X<99%	100%
6.2.(1-4.)2.	Static (Cat. 2), X<60%	Dynamic (Cat. 3), X<60%	100%
6.2.(1-4.)3.	Static (Cat. 2), X<99%	Dynamic (Cat. 3), 1<X<25%	100%

No	Three-category Combination: Nature, Built environment and Dynamic elements		Total %
7.3.(1-8.)1.	Nature (Cat. 1), 1<X<25%	(Static (Cat. 2), X% + Dynamic (Cat. 3), Y%) < 99%	100%

Figure 17. Urban scenario. Visual element categories, two- or three-category combinations and their amount (dominant, in balance, subordinate with indicative percentages). The extracts are from Figures 3, 13, 14, 15 and 16.
Source: Authors' own work

Suburb scenario. The static built environment elements, coupled with nature elements (4.2.(1–4.)2) (Figure 13), as well as the two-category combination of nature and dynamic elements (5.2.(1–7.)2) (Figure 16) most likely belong to the suburban scenario (Figure 18) when both parts of the pair are approximately balanced. In the suburban scenario, the static and dynamic elements are less likely to be visible simultaneously (Figure 15); therefore, we have not included them in this scenario. In the suburban scenario, of the three-category combinations, the nature elements percentage is approximately in balance with the total percentage of the built environment and dynamic elements (7.3.(1–8.)2) (Figure 17). Like the urban scenario, in the suburban scenario, the percentage of nature element is a vague indicator since, e.g. in limited, close-up views, it might cover the whole image area.

Rural scenario. The static, built environment elements, coupled with nature elements (4.2.(1–4.)3) (Figure 13), as well as the two-category combination of nature and dynamic elements (5.2.(1–7.)3) (Figure 14) most likely belong to the rural scenario (Figure 19). In these combinations nature elements dominate the built or the dynamic elements. In the rural scenario, of the three-category combinations, the nature elements dominate the built and dynamic elements (7.3.(1-8.)3) (Figure 16).

Nature scenario. The photographs with only visual elements of nature (Figure 3) most likely belong to the nature scenario (Figure 20). The static built environment elements, coupled with nature elements (4.2.(1–4.)4) (Figure 13), as well as the two-category combinations of nature and dynamic elements (5.2.(1–7.)4) (Figure 14) most likely belong to the nature scenario only if the static or the dynamic elements occur in very small amounts. In the nature scenario of the three-category combinations, the nature elements greatly dominate the static and dynamic elements (7.3.(1–8.)4) (Figure 16).

No	Two-category Combination: Nature and Built environment elements		Total %
4.2.(1-4.)2.	Sky (Sky) or Greenery (G) or Water (W) or Ice or snow (I), X<60%	Static (Cat. 2), X<60%	100%

No	Two-category Combination: Nature and Dynamic elements		Total %
5.2.(1-7.)2	Nature (Cat. 1), X<60%	Dynamic (Cat. 3), X<60%	100%

No	Three-category Combination: Nature, Built environment and Dynamic elements		Total %
7.3.(1-8.)2.	Nature (Cat. 1), X<60%	(Static (Cat. 2), X% + Dynamic (Cat. 3), Y%) < 60%	100%

Figure 18. Suburban scenario. Visual element categories, two- or three-category combinations and their amount (dominant, in balance, subordinate with indicative percentages). Extracts from Figures 13, 14 and 16
Source: Authors' own work

No	Two-category Combination: Nature and Built environment elements		Total %
4.2.(1-4.)3.	Nature (Cat. 1), Sky (S) or Greenery (G) or Water (W) or Ice or snow (I), X<90%	Static (Cat. 2), 10<X<25%	100%

No	Two-category Combination: Nature and Dynamic elements		Total %
5.2.(1-7.)3	Nature (Cat. 1), Sky (S) or Greenery (G) or Water (W) or Ice or snow (I), X<90%	Dynamic (Cat. 3), 10<X<25%	100%

No	Three-category Combination: Nature, Built environment and Dynamic elements		Total %
7.3.(1-8.)3.	Nature (Cat. 1), Sky (S) or Greenery (G) or Water (W) or Ice or snow (I), X<90%	10 < (X% + Y%) < 25%	100%

Figure 19. Rural scenario. Visual element categories, two- or three-category combinations and their amount (dominant, in balance, subordinate with indicative percentages). Extracts from figures extracts from Figures 13, 14 and 16
Source: Authors' own work

MG	Visual elements from one category	Total %
1.	Nature (Cat. 1), Sky (S) or Greenery (G) or Water (W) or Ice or snow (I), 100%	100%

No	Two-category Combination: Nature and Static environment (S) elements		Total %
4.2.(1-4.)4.	Nature (Cat. 1), Sky (S) or Greenery (G) or Water (W) or Ice or snow (I), X<99%	S <10%	100%

No	Two-category Combination: Nature and Dynamic (D) elements		Total %
5.2.(1-7.)4	Nature (Cat. 1), Sky (S) or Greenery (G) or Water (W) or Ice or snow (I), X<99%	D<10%	100%

No	Three-category Combination: Nature and (Static (S) & Dynamic (D)) elements		Total %
7.3.(1-8.)4.	Nature (Cat. 1), Sky (S) or Greenery (G) or Water (W) or Ice or snow (I), X<99%	S+D<10%	100%

Figure 20. Nature scenario. Visual element categories, two-category combinations and their amount (dominant, in balance, subordinate with indicative percentages). Extracts from Figures 3, 13, 14 and 16
Source: Authors' own work

4.2.2 Two- and three-category combinations in indoor views. In combinations of several categories, a wider angle of view is more likely than with visual elements of one category. In combinations of elements of two or three categories, interior views and window views have been examined as separate entities. However, it is possible, even likely (or at least desirable), that a window view is also visible, especially in wider interior views where a sense of depth is present. A wider view could evoke a sense of extension if the view would have "connection/-s between each element found in an environment" (Kaplan, 1995). The wider view also includes the possibility of Dynamic elements, the other people entering the view, causing visual or auditory distraction.

Nature–static element combinations. In indoor views, nature–static element combinations mean that the photo would most likely include parts of wall or ceiling structures (or other parts of the architectural envelope) together with house plants (e.g. living, mummified (embalmed) or silk (artificial) plants. The distance from the elements and the angle of the view (close-up or wider view) also provides possibilities for restorative aspects like one-category elements.

Nature–dynamic element combinations. In indoor views, nature–dynamic element combinations mean that the photo would most likely include furniture (or other parts of the interior orchestration) or other people, who are apparently the other knowledge workers. The nature elements in indoor settings are most likely house plants. The dynamic elements in indoor view contain a risk for distraction.

Static–dynamic element combinations. In indoor views, if only the static–dynamic element combinations (features of the architectural envelope and interior orchestration and people) are visible. At their best, a wider view could evoke a sense of extension if the view would "include connection/-s between each element found in an environment" (Kaplan, 1995) or sense compatibility through "characteristics found in an environment that meet the preferences and goals of a person" (Kaplan, 1995). The sense of compatibility with the

environment could be possible also in close-ups as well. The presence of people in indoor view poses a risk of distraction.

Nature–static–dynamic element combinations. In indoor views, the three element combinations (nature, static and dynamic) allow for the richest affordance and widest views.

4.3 Principles for preliminary quantification of the photographs

The preliminary quantification of the photographs is based on the eight visual elements and their division to three categories: *nature* (sky, ice or snow, water, greenery), *static* [built environment (outdoors)/architectural envelope (indoors)] and *dynamic* [furniture (i.e. interior orchestration), people and vehicles] visible in indoor views or window views (from inside to outside) (Figure 21). The percentage of each visual element (separately) in each photograph is analysed in AI-based MV analysis. After the MV analysis, the photos are grouped by visual categories, each visual element belonging to one of the three categories: *nature*, *static* or *dynamic* visual element categories.

The four scenarios urban, suburban, rural and nature scenarios are used as bases for the photographs' quantification (Figure 22). The photos are initially scored on a four-point scale from 1 to 4, with 4 being the highest and 1 being the lowest in relation to its (place's elements seen in the photo) assumed restorative effects. Tentatively, all photos are classified under one of the four scenarios. Photographs classified as urban scenario would receive 1, suburban 2, rural 3 and nature scenario 4 points. Photograph's location data (if the participants have allowed location tracking) or other disciplines' finding concerning the participant (who has taken the photograph) may change the preliminary rating. For example, a photograph classified as belonging to a rural scenario by its image content (connotation) receiving a score of 3 is confirmed to be photographed in a rural area (denotation), and the score remains 3. However, if the occupant had taken a photograph in a suburban area (denotation) and it had been tentatively classified to the urban scenario (connotation), its score would be upgraded from 1 to 1.5 points (less than the suburban scenario's score 2, but more than urban scenario's score 1). The score is raised because the denotation's affordance is presumably more favourable (e.g. for recovery during the workday) than can be inferred from the

Interior view Elements (Nature, Static, Dynamic) or their combinations, dominance or views (close-up or wider view)	**No window view**	**Window view to Outdoors**		
		Window view far away or small	Urban scenario/ Suburban scenario	Rural scenario/ Nature scenario
Dynamic (close-up view); Dynamic - Static (close-up view)	**1**	1,5	2	2,5
Nature – Dynamic and/or Static (dominance/close-up view)	1,5	**2**	2,5	3
Nature (dominance) – Dynamic and/or Static (wider view)	2	2,5	**3**	3,5
Nature; Nature (dominant) – Static (wider view)	2,5	3	3,5	**4**

Figure 21. Principles for preliminary quantification of the photographs, including both indoor views and window views

Source: Authors' own work

Connotation by the analysed image content	**Denotation** by the confirmed geographic location (e.g. known coordinates)			
	Urban Scenario	**Suburban Scenario**	**Rural Scenario**	**Nature Scenario**
Urban Scenario	**1**	**1,5**	**2**	**2,5**
Suburban Scenario	**1,5**	**2**	**2,5**	**3**
Rural Scenario	**2**	**2,5**	**3**	**3,5**
Nature Scenario	**2,5**	**3**	**3,5**	**4**

Figure 22. Principle of the preliminary quantification (scoring) of the analysed photographs

Source: Authors' own work

photograph's connotation. The principles of the preliminary scoring of the photographs are indicated in detail in Figure 22.

The photographs with an indoor view but without a window view are rated by the column "No window view", with low rates of 1–2.5 on a scale where 4 is the highest grade (Figure 21). In this column, the best rates are reserved for views with the dominance of the nature category (already proved to have restorative effects) together with wider views with Static elements (most likely providing visually calm but still including features of extension) (rate 2.5). If the view would also include a window view far away or even a small one (even no visible scenario to analyse), the rating would be upgraded with 0.5 points and the more nature-based views would be up to 4 points. On the other hand, the lowest grades (rate 1) are reserved for close-up views, with the dominance of the dynamic visual elements (or static elements) and lacking known restorative visual elements. Dynamic visual elements containing the other people (or non-used seatings) include risks for visual or auditive destruction. In these cases, the presence of a window view (even a very small one) upgrades the rating.

For the window view (Figure 21), the rating is based on the visual element combinations within one category (nature, static, dynamic), visual element combinations between categories, dominance of a visual element category or type of the views (close-up or wider view). For the window views, scenario-based outdoor (including semi-outdoors) photo analysis is applied, where photographs are divided into four scenarios (urban, suburban, rural and nature) based on the visual element content in the photograph or the known location data (if it is available). In the quantification framework for indoors, the use of these outdoor scenarios is mostly directive and therefore, the urban and suburban scenarios are considered as one group and similarly, the rural and nature scenarios are grouped together to form another group, the latter ones receiving higher rating (most likely more nature elements) than the former ones. The principles of the preliminary scoring of the photographs are indicated in detail in Figure 21. The proposed preliminary quantification of photos is tentative (Figures 21 and 22). The photographs or their quantification (numeric rating) do not, as such, provide any evidence of the places' favourable or unfavourable effects on the knowledge worker's health or well-being. The evidence of the possible effects will be indicated after combining and analysing them (quantified photographic data sets) together with the other data sets in interdisciplinary interaction.

4.4 Secondary application in organisations' premises: systematic baseline documentation

The secondary application of indoor photo analysis could be used as a researcher's tool for systematic documentation. For example, the variation of seating arrangement in the floor plan does not necessarily indicate variation in the affordance of views when lifting one's gaze from the screen. Researchers could use photo-analysis to systematically document and analyse workplace affordances in organisations' premises, such as specific office spaces, to gain a baseline understanding of the affordances of the existing interior settings (combination of the architectural envelope and the interior orchestration) and their relation to the window views. In this phase, the researcher would need to have a furnished floor plan, and make sure the furniture is in the same places as in the physical space. Then, the researcher would systematically be seated in each workstation and on all the other available seats and take a photograph when raising one's gaze from the screen as the occupant would do. The MV-based analysed photographs would then be categorised similarly to the participants' self-reported photographs. This way, it would be possible to concretise what is the real variation in the affordance of available workstations or other places available for working, even if not designed as such.

5. Ethical considerations

The interdisciplinary research setting necessitates following national ethical guidelines, by acknowledging each discipline's conventions and following the strictest. All phases and sub-areas of photo analysis (from collecting images to their processing and storage as well as analysis, grouping and combining with other materials) are evaluated in the ethical review, even though photo analysis is only one part of the shared interdisciplinary research project. In our case, we will comply with the ethical guidelines of the Finnish National Board on Research Integrity (TENK, 2026) and current legislation (e.g. the EU's General Data Protection Regulation 679/2016 (GDPR) and the Data Protection Act 1050/2018). The finnish national board on research integrity is a member academy of the European Federation of Academies of Sciences and Humanities ALLEA, thereby following The European Code of Conduct for Research Integrity (ALLEA, 2017). Based on these guidelines, participation should principally be voluntary and based on an informed consent. The risk that participation in the study would cause harm to participants is small, and participants will be informed of safety issues related to working outdoors (e.g. traffic, tripping). Data protection is central to the project as the processing of personal data is necessary to carry out the research (e.g. identification of participants, location data and later merging data sets e.g. with health-related measures). In our case, the involved institutions will act as joint controllers and will conclude an agreement on the division of their duties. Based on previous research cooperation, our consortium has experience and good practices in handling data management and protection issues together in accordance with the data protection principles and obligations outlined in the GDPR. The data protection level of any service provider (e.g. ESM) will be assessed, and a written agreement on the processing of personal data will be drawn up. In our case personal data will not be transferred outside the EU/EEA area.

The processing of personal data requires a legal basis, such as consent or public interest. Participants will be instructed about legislation on the protection of domestic peace when it comes to taking photos, for example, in their residential environment. All photographs featuring people will be processed before analyses to ensure the people are not identifiable. The novel techniques are now emerging to obfuscate privacy-threatening objects in images, in real-time (see e.g. Xu *et al.*, 2024). Incorporating these techniques both into the MV pipeline as well as ideally in a bespoke software solution that manages the photograph taking process along with the EMSs could be considered in the future. The rights to the use of photographs (e.g. in publications) will be transferred to the consortium to the extent that is necessary for project goals. Data collected in the study will be pseudonymised before analyses take place. Regarding archiving and further use of data, not all material can be anonymised (e.g. location information that could reveal a participant's place of residence).

When reporting research results, it is often necessary to illustrate the findings (e.g. representative of a specific group or category) visually instead of just textual descriptions. However, due to the challenges of anonymising the data, it is questionable to use photographs taken by any participant. Should the photos attached to the scientific article be taken by the researcher or produced by AI according to the given parameters to protect the privacy of the research subjects? If such a practice were to be adopted, the state of the matter and the reason for it should be clearly brought out in every scientific report.

6. Discussion

Photographs depicting the gaze of a hybrid worker serve as the premise for a location-based visual analysis. The analysis phase consists of identifying the main meanings (denotation) and searching for other meanings and interpretations (connotation) of the locations.

The shooting and reporting of photographs with mobile-based ESM by workers while working support a place-based approach in the phase of identifying denotations. Photographs together with workers' immediate reactions (e.g. about job tasks and their compatibility with the location) are relevant since the places of hybrid work are not known in advance, or for other reasons researchers do not have access to them. The possibility to add a timestamp and coordinates to the reported ESM data, if consent is given, is necessary for further enquiries of the place such as the possibility to merge data sets (e.g. with data sets collected from the same occupant, or with data sets about the qualities of the place e.g. weather conditions).

Identifying the elements selected for photo analysis and their percentages on the image surface is considered to determine the main meaning (denotation) of the place documented in the photograph. For example, research literature emphasises the beneficial effects of nature (connotation), typically defined as greenery or vegetation in various forms, whether an indoor houseplant or a green wall, an outdoor planting or a broader green view. If the focus of the study is only on greenery, the analysis could be targeted in denotation phase to the presence or absence of greenery in the workers' view (as shown in the photograph) together with its percentage on the image surface. Similarly, the other elements of Nature (water features/body of water, sky) and their seasonal manifestations (snow/ice) on the image surface could also analysed if visible in the photograph.

In this first, mechanical analysis phase in search for main meaning (denotation), other elements visible on the image surface (static elements: built environments; dynamic elements: people and vehicles) and their amounts (percentages) are also analysed either *per se*, in relation to each other or to the elements of nature. And then categorised by this content.

The quantified photo analysis can also serve as a documentation tool for researchers to assess the homogeneity or heterogeneity of the working environment in an organisation's premises. This is to identify workstations with different views to determine whether workers have genuine options to choose from. This use of quantified photo analysis as researcher's documentation tool also falls within the first-stage analysis in search of the main meaning (denotation).

After the mechanical analysis phase, meanings and interpretations (connotations) are sought for the photographs' contents. Workers' workstation choices within an organisation's premises or other locations communicate (at least to some extent) their preferences and their former experiences of similar job tasks in relation to the chosen place (connotation-sender and code).

Affordances play a key role in the search for the meanings of the elements on the image surface (connotation-receiver) to find out possible demands and resources the place documented in the photo might have. For example, Dynamic elements (furniture, people, vehicles) could be seen possibilities for favourable actions or sources of distraction. Considering current research literature, elements associated with Nature are interpreted as being primarily positive elements. Static elements (built environment, both indoors and outdoors) require detailed analysis to avoid being seen only as negative sources of demands, in contrast to the elements of nature. In fact, the basis of interpreting the built environment also fit well into ART (Kaplan and Kaplan, 1989; Kaplan, 1995). In addition to greenery, the formation of space (in relation to "extension") and the interesting elements that evoke "fascination" and "being away" are less studied contents of ART in the broader context of the physical environment. MV analysis could also be included in the connotation phase to pre-identify the various formations of space, enabling researchers to advance their meanings and interpretations.

The photos sent by single occupants from different hybrid work locations where one has been working (workstation choices at office environments or other places in- and outdoors)

can be analysed separately or seen as forming a network of locations. Combining similar data from a larger group of subjects could reveal similarities in hybrid work location choices or in types of locations within a specific organisation, or across the same urban or suburban areas. Such densifications may be key to understanding the strengths and development targets of hybrid work locations.

7. Conclusion

The development of quantified photo analysis was driven by the need to understand where and in what kind of places hybrid work is done. The design-oriented question-setting led to a location-based approach, since a diverse understanding of a place, which also includes visual content and its interpretations, forms the premises of spatial design. We initiated the development of both indoor and outdoor photo-analysis method to support documentation and analysis of the physical environment from a worker's perspective, called QPA-HW. Since we are conducting interdisciplinary research together, the goal was also to consider how we could produce quantified data from visual material analysis, but it would still be relevant for architectural researchers. This way, we could compare or combine the quantified visual material with numeric data produced by other disciplines, e.g. survey responses or data collected with wearable devices.

In this paper, the indoor photo analysis was combined with the outdoor (and semi-outdoor) photo-analysis we have been working with earlier. We introduced four methodological conditions as the background for the photo analysis. The mobile-based ESM fulfilled the first condition, which was that the photographs would be self-reported by the occupant, accompanied by a short multi-choice questionnaire. ESM fulfilled our second condition, which was the possibility of attaching a time and location stamp to the self-reported photos. The AI-based MV analysis approach supported our third condition, which was to automate labour-intensive workflows for identifying the chosen elements from the photographs. MV analysis also supported our fourth condition to quantify the photos' qualitative content, since it could operate by analysing percentages of the set elements from the photo's image surface. In this article, we considered these four conditions as a background for the substance of the photo analysis. This paper's theoretical content is related to the domain-specific extension of the JD-R theory (Demerouti *et al.*, 2001; Bakker and Demerouti, 2018), the ED-R model (Roskams and Haynes 2020; Roskams and Haynes, 2021) and the ART (Kaplan and Kaplan, 1989; Kaplan, 1995). The photo analysis was planned to support the ED-R strategy, which involves mitigating environmental demands and resources through a design knowledge perspective with an affordance-based approach and the settings-based health promotion approach. Within the framework of the photo analysis, we were able to expand and advance the ED-R's "greenery" approach to consider other elements of the built environment. This extension supports ART, where the restorative effects are not limited to green plants.

The QPA-HW was based on analysing eight visual elements divided into three categories: *nature* (sky, ice or snow, water, greenery), *static* [built environment (outdoors)/architectural envelope (indoors)] and *dynamic* [furniture (i.e. interior orchestration), people and vehicles] visible in indoor or outdoor views or window views (from inside to outside). The percentage of each visual element in every photograph. The photos would be then grouped by visual categories, each visual element belonging to one of the three categories: nature, static or dynamic. The rating of the photographs would still be preliminary to (only) support the combining or comparing processes with the quantified data produced by the other disciplines. The (possible) evidence would be produced from this comparison process with the other disciplines' researchers. As a secondary purpose, we proposed that photo analysis

could also be used as a researcher's tool for systematic documentation of office environments. In its current form, QPA-HW already offers a model for systematically analysing the physical environment of hybrid work, allowing the results to be combined with time-space-bound data from other scientific disciplines to obtain comprehensive evidence of the environment to which workers are exposed in different locations while performing hybrid work. Although the undeniable advantage of the method is its applicability to interdisciplinary collaboration, it is unfortunately also a limiting factor for its use. On a practical level, the requirement for interdisciplinary collaboration necessitates the formation of larger, multidisciplinary teams, which in turn lead to larger projects requiring funding.

The methods currently used for data collection and analysis (ESM, including location tracking, short surveys and photo collection and MV analysis and quantification of photos) are already in use, although, to our knowledge, they have not been used together in the context of hybrid work environments. We assume that once the photo analysis presented in this article is tested and validated in practice, it will have a good chance of becoming a useful part of the methodological palette for knowledge work environment research.

We are aware that the interdisciplinary research setting requires following national ethical guidelines by acknowledging each discipline's conventions and following the strictest. All phases of photo analysis, from collecting images to their processing and storage, as well as analysis, grouping and combining with other materials, are necessary to evaluate in the ethical review.

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Corresponding author
Aulikki Herneoja can be contacted at: aulikki.herneoja@oulu.fi