ACTIVE4: A Conceptual Framework for Gathering Empathetic Insights toward Office Workers' Vitality Ecosystem Design

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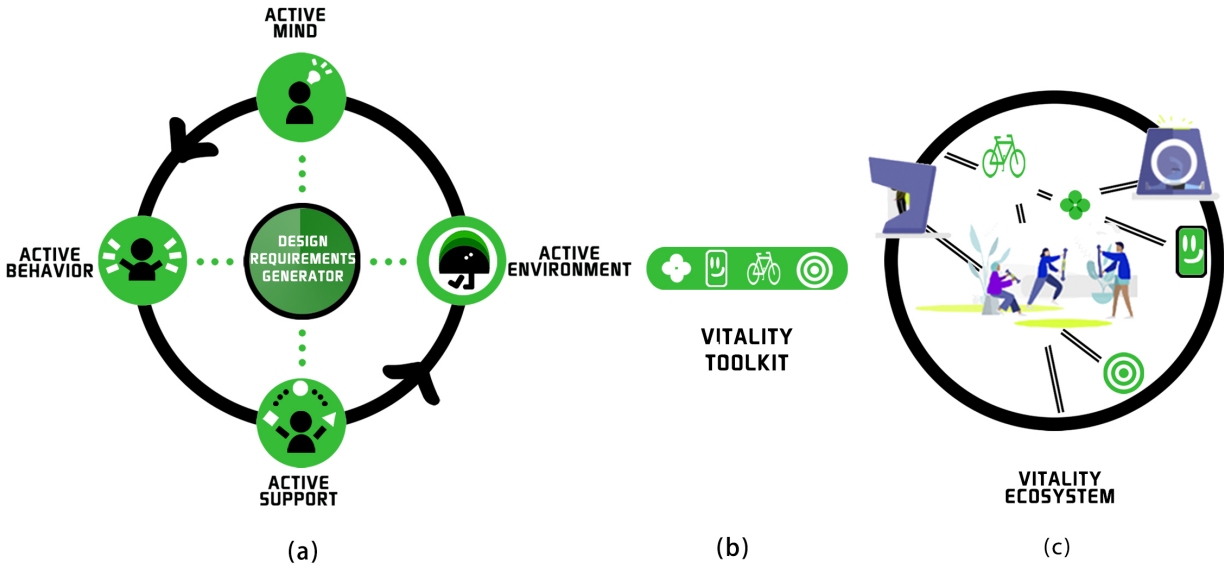

Figure 1: The ACTIVE4 framework includes (a) four core factors to explore the design requirements of a vitality ecosystem, (b) a vitality toolkit designed based on the core factors for continuously collecting officer workers' data and supporting the understanding of their needs for reducing physical inactivity, and (c) a vitality ecosystem is created with solutions that adapt to every office worker's needs.

ABSTRACT

Sedentary behavior (SB) is prevalent in workplaces, putting office workers at an increased risk of severe health problems. To help designers and researchers gain a better understanding of office workers' contextual concerns for physical inactivity (reducing SB and enhancing physical activity (PA)), we have proposed a conceptual framework ACTIVE4. This framework advises designers and researchers to consider four key factors that influence office workers' physical inactivity: active mind, active behavior, active support, and active environment. We conducted three workshops (N=28 design students) to evaluate the framework. The participants found ACTIVE4 helpful in guiding them towards a more systematic understanding of the environmental influences and office workers' personal needs for reducing physical inactivity. In future work, we will optimize the ACTIVE4 framework's learning curve as suggested by participants and conduct an expert study to further discuss design opportunities and requirements for the ACTIVE4-related vitality toolkit.

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CCS CONCEPTS

• **Human-centered computing** → **User studies**; *HCI theory, concepts and models.*

KEYWORDS

conceptual framework, design guideline, sedentary behavior, behavior change, hybrid workshops

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1 INTRODUCTION

After a long sedentary working day next to my desk, I receive a vibration on my watch, reminding me to stand up and make some movements. I look around at our shared office and my busy colleagues, wondering "What should I do? I feel awkward doing the stretching next to my desk." Sedentary behavior (SB) is highly prevalent in office-based workplaces [10, 15]. High levels of SB combined with low levels of physical activity (PA) put many office workers at increased risks for severe health problems such as cardiovascular diseases, Type II diabetes, obesity and so on [1, 6].

Harrison et al. [12] pointed out that in the human-computer interaction (HCI) paradigm 3.0, the design goal is often not just designing an independent product, but an ecosystem that supports people's situated actions in the world. It brings an ecosystem vision of relationships between human behavior, contexts, technology, and the world as the design target. Taking this ecosystem vision into consideration, our previous work identified four key factors that contribute to the reduction of office workers' physical inactivity [42], including **active mind** and **active behavior** as two personal factors, and **active support** and **active environment** as two organizational factors. A description of the four factors is detailed in Section 3. These four factors work together to enable designers to not just focus on designing single products, but systematically design a package of solutions that work together and adapt to the workplace as a vitality ecosystem for reducing office workers' physical inactivity.

Existing product solutions often only target reminding users to move or increasing their awareness of physical inactivity. For example, applications in combination with wearables, such as smart watches, are often used to give information or prompts, and as a data collection tool [5, 35]. Many other physical products use ambient lighting [3], digital visualization [37], and pressure sensors [41] to make users be aware of their levels of inactivity.

Extensive research has been conducted with the goal of helping reduce SB, and/or promoting PA for office workers [4, 28]. Some research focus on increasing people's awareness of their SB (i.e., active mind) [11, 13, 32]. Kanaoka and Mutlu [17] designed a motivational agent that aims at increasing people's intrinsic motivation for behavior change (i.e., active behavior). Esakia et al. [7] introduced *FitAware* that takes into consideration of both active mind (i.e., increasing people's awareness of their fitness data) and active support (i.e., encouraging group cohesion in PA interventions). However, rarely founded research that has considered all four factors.

In this late-breaking work (LBW), we proposed a conceptual framework called "ACTIVE4". With ACTIVE4, we aim at helping designers and researchers consider all four factors that impact office workers' physical inactivity, and systematically design a package of solutions for office workers rather than focusing only on single-product solutions. Therefore, our research question (RQ) is: How does ACTIVE4 support designers and researchers to design solutions for reducing office workers' physical inactivity?

To answer this RQ, we recruited 28 design students and conducted three rounds of workshops to collect their feedback on ACTIVE4 and observed how ACTIVE4 was used to support their research and design process. The participants found ACTIVE4 helpful in enabling them to consider a full picture of influential factors when they specify the design requirements. This LBW has made two main contributions: (1) Define a framework "ACTIVE4" based on existing behavior change models that guide designers and researchers to systematically consider the factors that contribute to office workers' physical inactivity; (2) Run three rounds of hybrid design workshops to evaluate how ACTIVE4 supports the understanding and data collection of officer workers' physical inactivity. In future work, we will improve the learning experience of ACTIVE4 as suggested by participants and conduct expert studies to further explore vitality toolkit design opportunities.

2 RELATED WORK

This section lists a review of behavior change models, product solutions and research on sedentary behavior change, and advantages and challenges of conducting online or hybrid research workshops.

2.1 Behavior Change Models

A plethora of models for behavior change have been defined to characterize interventions and analyze the targeted behavior (e.g., [8, 20, 24]. Hekler et al. [14] classified four forms of behavioral theories, namely metamodels, conceptual frameworks, constructs, and empirical findings, among which conceptual frameworks provide more specific guidance to the design and implementation of behavior change technologies and help guide the evaluation process.

Fogg's behavior model (FBM) [8] pointed out that, for a person to perform a target behavior, he or she must (1) be sufficiently motivated, (2) have the ability to perform the behavior, and (3) be triggered to perform the behavior. These three factors must occur at the same moment, else the behavior will not happen. Similarly, in the Behavior Change Wheel (BCW) proposed by Michie et al. [25], the center of the BCW is a "behavior system" involving three essential conditions: (physical and psychological) capability, (physical and social) opportunity, and (reflective and automatic) motivation, termed as the "COM-B system" [39]. The COM-B model recognizes that behavior is part of an interacting behavior system that involves all three conditions [39]. These behavior change models serve as a theoretical background for defining the ACTIVE4 framework.

2.2 Product Solutions and Research on Reducing SB and/or Promoting PAs

Some leading companies have built-in tailored vitality ecosystems to support office workers' well-being. For example, *Adidas World of Sports Arena office*[1] has sports fields inside the building and employees can grab a bike to move between meetings. However, this kind of built-in tailored vitality system is not affordable for many other companies. Apart from office buildings and facilities, digital products also spring up. For example, smart wearables (e.g., *Apple Watch*[2]) can track users' inactive statuses and enable people to be more aware of their personal well-being data. *Ology™ Active Touch Desk* from *Steelcase*[3] reminds users to move and change their postures throughout the day. *Ant Forest* from *Alipay*[4] uses users' daily PA data as virtual green power to grow a digital tree. To motivate users to do more PAs, *Alipay* will plant a real tree in the northwest of China when the digital tree is grown up. In this way, users can see how their PAs can collectively scale up the climate actions. Aside from product solutions, extensive research has been conducted for evaluating interventions that aim at reducing SB and/or promoting PAs. Some research worked on interventions that remind users to perform PAs at pre-defined time intervals [11, 29, 37], and others provide guidance to users to do PAs at ideal intensity or frequency [2, 18, 31]. Landais et al. [19] found in their study that, in addition to "health" as a value, other social and work-related values are also given priority by office workers. There are often dilemma situations. For example, when office workers get an SB reminder in a meeting, should they call for a break or finish the meeting? It remains challenging to promote PAs for all office workers without interrupting their working schedules.

Most research and product solutions are targeting at specific one or two factors, such as increasing people's awareness of their vitality data (i.e., active mind) or providing physical and social support (i.e., active support). Designing future solutions for reducing SB and enhancing PAs should consider all four factors together to enable a comprehensive understanding of office workers' social and personal needs around vitality.

2.3 Conducting Online and Hybrid Research Workshops

With social distancing rules in the time of the pandemic, it sped up the movement from offline to online and hybrid research methods, which open new avenues for research and the potential to develop new methodological approaches. Many researchers have used video conferencing tools and social virtual reality (VR) platforms to run online or hybrid academic workshops (e.g., [21, 22]) that enable both online and offline participants to have interactive group discussions and collect discussed materials in the form of shared slides (e.g., Google Slides[5]) or Miro boards[6] [33]. Shamsuddin et al. [33] discussed many advantages and challenges of conducting online or hybrid workshops. Advantages include enabling participation without traveling, which saves time and costs. It also removes the geographical and accessibility barriers to recruiting international participants. Challenges include the stability of internet connections, lack of non-verbal communication, and so on. These lessons learned are well-considered when we were defining the study methodology.

3 THE ACTIVE4 FRAMEWORK

To have a complete picture of factors that can impact office workers' physical inactivity and gain empathetic insights, we propose the ACTIVE4 framework (Figure 1).

3.1 Four Core Factors in ACTIVE4

Inspired by Fogg's Behavior Model (FBM) [8] and the Behavior Change Wheel (BCW) defined by Michie et al. [25], the framework incorporates four factors: active mind, active behavior, active support, and active environment [42]. **Active mind** is associated with people's awareness and willingness towards participating in PAs to reduce SB. **Active behavior** refers to the fact that people have their own motivation and PA requirements in their preferred scenarios. **Active support** involves physical and psychological support (e.g., exercise facilities or office well-being programs) that encourage office workers to step away from the screens, having microbreaks and joyful interactions. **Active environment** indicates that the working space should have nearby and easily accessible activity areas (e.g. a few steps away from the working area) as well as provide social persuasion that triggers people to do PAs. As office workers' active behavior is improved, it will positively influence their active mind, forming a virtuous circle.

3.2 How to Use ACTIVE4

In the center of the four factors is the design requirements generator (Figure 1a) that incorporated all the factors into an envisioned future vitality ecosystem. Designers and researchers are guided to consider active mind, active support, and active environment with the goal to support active behavior. An example of how to use ACTIVE4 is described as the following four steps. By stepping into the shoes of individual sedentary office workers, **Step 1** sensitizes designers and researchers with examples to help them understand the four core active factors and gain empathetic insights. **Step 2** invites designers to design the vitality toolkit based on the four factors. **Step 3** places the vitality toolkit in the work environment that collects data and helps designers and researchers understand officer workers' contextual concerns for SB and PAs. **Step 4** is a co-design session. Designers and researchers work together with office workers to define and synthesize design requirements into a vitality ecosystem to integrate everyone's preferences and needs.

4 METHODS

To evaluate ACTIVE4 and gain insights into how designers and researchers use ACTIVE4. We conducted three hybrid workshops

[1] *Adidas World of Sports Arena office*: https://archello.com/project/adidas-world-of-sports-arena, retrieved on Jan. 8, 2023
[2] *Apple Watch*: https://www.apple.com/watch/, retrieved on Jan. 8, 2023
[3] *Ology™ Active Touch* from *Steelcase*: https://www.steelcase.com/products/height-adjustable-desks/ology-desk/, retrieved on Jan. 8, 2023
[4] *Ant Forest* from *Alipay*: https://unfccc.int/climate-action/momentum-for-change/planetary-health/alipay-ant-forest, retrieved on Jan. 8, 2023
[5] Google Slides: https://www.google.com/slides/about/, retrieved on Jan. 9, 2023
[6] Miro: https://miro.com, retrieved on Jan. 9, 2023

with a total of 28 design students, using generative techniques that include digital tools (e.g., stock images and icons) and physical tools (e.g., paper and pens) to support designers to sketch, exchange, and present ideas [34, 36]. The recruited participants were divided into three groups for the three workshops and participated on-site in a studio at the university campus. Due to geographical and pandemic restrictions, the workshop facilitator joined each workshop through a video conferencing tool. All the workshops were video and audio-recorded, and the conversations were transcribed. This study has been approved by the Ethics Review Board from the Eindhoven University of Technology (Reference No. ERB2022ID74) and a voluntary informed consent has been obtained from each participant. Participants did not receive any incentives.

4.1 Participants

We recruited 28 participants (10 males, 18 females), aged between 19-26 (M = 21.2, SD = 2.5), who are design students with a technical background (i.e., undergraduate and graduate students who have design and technical implementation skills) from two universities. The reason why we recruited design students is that they are still at the learning stage, so the scope of their skills is not limited to certain areas such as interface design or product design as compared to experienced designers. Participants were assigned to one of the three workshops (W1, W2, and W3) according to their availability (W1: N=7 (4m, 3f); W2: N=12 (2m, 10f); W3: N=9 (4m, 5f)).

4.2 Tools and Procedure

A pre-designed *Miro Board*[7] was used in each workshop as an online collaboration tool for participants to discuss, visualize, and share ideas. At the end of each workshop, an online survey using *Poll Everywhere*[8] was sent out to each participant to collect their feedback on using ACTIVE4 and their improvement suggestions. Each workshop consists of four parts: (1) **Introduction**: The workshop facilitator introduced the research background and engaged participants in a voting exercise to clarify the concepts of SB and PAs. (2) **Sensitization**: The facilitator prepared a self-designed showcase vitality toolkit on Miro, with which participants walked through the four core factors to understand the ACTIVE4 framework. (3) **Design**: Participants used ACTIVE4 to collect design requirements and design their toolkits. (4) **Survey**: The workshops ended with a survey with open-ended questions that invited each participant to write down their overall experience in using ACTIVE4 and improvement suggestions.

4.3 Data Analysis

The analysis process followed the open coding approach [40]. Two researchers and also co-authors of this paper read through the transcribed data, independently marked the data that are relevant to the research question, and turned them into labeled statements. Next, the two researchers categorize the statements using affinity diagrams [27] to identify key themes. All the identified themes and clusters were reviewed, discussed, and revised by all the co-authors to validate the qualitative analysis.

[7]A pre-designed *Miro Board* as a collaboration tool used in the workshops: https://miro.com/app/board/uXjVPyl_Hpw=/?share_link_id=414833705487

[8]*Poll Everywhere*: https://www.polleverywhere.com, retrieved on Jan. 12, 2023

5 RESULTS

Three key themes emerged from the affinity diagrams, namely (1) participants' learning curve of the ACTIVE4 framework; (2) ways that participants used ACTIVE4 to define design requirements and design their toolkits; (3) participants' positive feedback and improvement suggestions for the ACTIVE4 framework. Participants are labeled as W#-P#. For example, W1-P1 represents Participant 1 from Workshop 1. The photos of the hybrid workshop are available in Section 2 of the Supplementary Material.

5.1 Participants' Learning Curve of the ACTIVE4 Framework

Five participants pointed out that much cognitive load was required to understand the connections between the four factors and learn to use the ACTIVE4 framework in a short time. As mentioned by **W2-P3**, *"The framework is very theoretical with few examples to help me understand each factor thoroughly in a short time."* Similarly, **W3-P2** also said, *"Although the framework is meant to help me step by step, it requires quite some effort to learn. I feel that we need to have some knowledge of behavior change in order to grasp the core ideas of the framework in a short time."*

However, **W3-P8** told that *"At the beginning, I felt that my understanding of the framework was superficial, but after seeing the design showcase that explained the framework step by step, I started to understand it and found it was a good tool to help define design requirements."* **W1-P2** gave suggestions on helping designers understand the framework better by provide hints and examples that explain the core factors, their connections and their influences on officer workers' behavior (*"I expected to see more hints and examples of each factor, especially examples about how these factors are interconnected and what design requirements and outcomes can derive from considering the factors."*)

5.2 How Participants Used ACTIVE4 and Their Design Outcomes

We observed that all participants followed the four steps and instructions described in Section 3.2. They started by exploring the four core factors with the example toolkit during the sensitization session (**Step 1**). Afterward, they had a brainstorming session to design a vitality toolkit based on the core factors (**Step 2**). Next, they envisioned placing the toolkit at their workplace and considered themselves as individuals who have prolonged sitting habits. They discussed the possible data that can be collected using these toolkits and defined design requirements(**Step 3**). Finally, they co-designed vitality ecosystem scenarios according to the synthesized design requirements at their workplace (**Step 4**).

Six participants mentioned that they preferred to do interviews and observational studies with office workers to ensure the design requirements are generated based on a solid understanding of the physical and social environments of the workplace and officer workers' needs. **W1-P6** said, *"This framework brings a new way of thinking about user research at the exploratory stage. It gives me a structural idea of what questions I need to ask my users."* In Step 2, 28 participants generated eight vitality toolkits (see Figure 2). The description of the vitality toolkits and how they are used to

continuously collect office workers' vitality data are described in Section 1 of the Supplementary Material.

5.3 Participants' Positive Feedback and Improvement Suggestions

We received much positive feedback on ACTIVE4. Participants believe that ACTIVE4 enables them to structurally and systematically identify problems. As **W3-P3** said, *"This framework enables me to comprehensively consider diverse factors that influence people's activities at work. The solution that I came up with did not just force office workers to do exercise, but fully considered their personal, social needs and the overall working environment. "* **W3-P2** commented that, *"I agree with the four factors of the framework. It connects people with their environment as a whole to improve people's vitality. "* Participants also agree that the framework provides theoretical support for them to understand behavior change and helps them better define research questions and design requirements. **W3-P4** told us that *"The framework has reshaped my thinking process and enables a more user-centered way to approach a problem. It is a practical guide to design and even evaluate behavior change interventions."*

Besides giving concrete examples for participants to understand the core factors effectively (see Section 5.1), another improvement suggestion is that ACTIVE4 should provide guidance on how to evaluate and measure the effectiveness of the design solutions. For example, apply what research methodology to compare the pre-and post-intervention behavior, and use what (technological) devices to collect qualitative and quantitative measurement data. As pointed out by **W1-P6**, *"It is a framework that helps us understand users and their contexts better at the exploratory stage, but it doesn't include guidance for the evaluative stage after the design solutions are implemented, which we shouldn't neglect."*

6 DISCUSSION

In this section, we reflect on lessons learned, study limitations and future research opportunities.

6.1 Enhancing Physical Activity (PA) and Reducing Sedentary Behavior (SB)

The current changes in working styles (e.g., from onsite to remote working) have dramatically impacted office workers' lifestyles and exercise habits [30]. Olsen et al. [26] found that, with flexible work, employees' PA was not impacted, but SB had increased. SB refers to an energy expenditure $\leq$ 1.5 metabolic equivalents while in a sitting or reclining posture during waking hours and not simply the absence of PA. Many studies have examined the efficacy of interventions for enhancing PA levels (e.g., [9, 16]), but it remains unknown whether these interventions can also reduce SB. On contrary, office workers who increase their PA levels might become more sedentary throughout the rest of the day feeling satisfied that they have done PAs. As the result, enhancing PA and reducing SB, these two interconnected yet independent intervention strategies, should be considered together as part of the future ACTIVE4 framework.

6.2 Adopt ACTIVE4 in Organizations

In this study, we invited design students to use ACTIVE4 as a guideline to systematically design solutions for office workers' vitality. In a bigger future picture, we would like to have companies and organizations incorporate ACTIVE4 as part of their employee care strategies. With the impact of the pandemic, there are often complaints about long virtual meetings, lack of social connections, and reduced physical activities, making employers and employees rethink the relationship between work, well-being, and the working environment.

Welke [38] who manages health management and work-life integration at *Adidas* stressed that each employee is responsible to build their own healthy life habits, but companies should support them by building an active workplace. At *Google* [23], their playful and whimsical offices operate on the belief that if the people who are working there are happy, healthy, and comfortable, then the company itself will thrive. These views are in line with our vision that we should invest on designing a vitality ecosystem for office workers, not just one single product solution. We envision that ACTIVE4 can serve as a communication platform for stakeholders (e.g., office workers, researchers, architects, finance and human resources managers, etc.) to co-design a vitality ecosystem at work.

6.3 Lessons learned and Opportunities for Conduct Online and Hybrid Research Workshops

Due to geographical and pandemic restrictions, the workshops were conducted in a hybrid format. The participants were offline while the workshop facilitator joined each workshop session through a video conferencing tool. *Miro* boards and an online survey platform *Poll Everywhere* were used to support the data collection and collaboration between participants and the facilitator. Several lessons are learned. First, since each workshop had at least seven participants, we experienced some difficulties to conduct group interviews. Some participants remained silent, while others dominated the interview discussions. As an alternative, the facilitator also prepared an online survey as a backup with open-ended questions that are intended to be asked in the group interview. In the survey, each participant was required to write down their answers to the questions. Second, in addition to digital tools, physical tools (e.g., papers and pens) were preferred by offline participants to sketch their design ideas. By taking photos of their sketches and uploading them to the Miro board, they managed to communicate with the facilitator. However, the switch between online and offline discussion was not frictionless, which added extra work for participants. In addition, we see that online and hybrid research methods have provided many opportunities to enable researchers to broaden their research scope by reaching out to international participants. The digital tools collect and digitalize the data during the research study, reducing researchers' effort in data processing.

6.4 Limitations

We are aware of the limitations of this study. First, although the hybrid format provides many benefits, the lack of non-verbal communication between the online facilitator and the offline participants may result in losing valuable insights. Second, each workshop last

Figure 2: The eight vitality toolkits designed in the three workshops

about 3 to 3.5 hours, which can be tedious for participants. Third, the recruited participants are university students (i.e., undergraduate and graduate students). It will be valuable to recruit experienced designers for the future iteration of the framework. The limitations will be well-considered in future work.

7 CONCLUSION

This LBW proposed a conceptual framework ACTIVE4 to help designers and researchers have an overview of the contributing factors to office workers' sedentary behavior and guide them to systematically design solutions that enhance office workers' PA. This framework advises designers and researchers to take into consideration how to enable office workers' active mind by increasing their awareness of sedentary behavior, and also how to enable active physical and psychological support as well as active environmental triggers to increase office workers' capability and motivation to improve their levels of PA and reduce SB. Three workshops were conducted with a total of 28 design students to evaluate the framework. The design students found ACTIVE4 helpful in guiding them step by step towards a more systematical understanding of the environmental influences and office workers' personal and social needs in being more physically active during work. In future work, we will extend the ACTIVE4 framework with evaluative and measurement strategies as suggested by participants and conduct the study to further develop the vitality toolkit. We also want to promote the ACTIVE4 framework to companies and organizations to increase the stakeholders' awareness of employees' well-being and evaluate the framework in a real corporate context.

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