# More than Step-count: Designing a Workplace-based Activity Tracking System

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## ABSTRACT

The 'one-size-fit-all' approach used in the current activity tracking devices such as FitBit, Jawbone, and Smartwatches may not be enough to encourage healthier behavior patterns in people, as much more considerate design is required to create meaningful experiences. This paper focuses on designing an activity tracking system that can be used in a workplace setting. We apply a grounded approach, where we aim to understand employee's perceptions of physical activities at workplaces and the role an activity tracker can play in supporting that. We describe a three-phase design process, which involves 1) interviewing employees who participated in a large-scale employer-sponsored health and wellness program; 2) two participatory design workshops that aimed at understanding the role of activity tracking in workplace contexts and generating ideas for activity tracking applications; and, 3) studying the use of the resulting design prototype – QUTgo as a 'technology probe' to gather insights into the potential of physical activity tracking in workplaces. This paper contributes to the emerging repoirtoire of studies on activity tracking by providing a user-centric perspective on how to design an engaging activity tracking system that takes into account employees' perspectives and experiences and the dynamics of specific work settings.

## KEYWORDS

Activity Tracking, Design, Workplaces, Mobile App, Physical activities

## 1 INTRODUCTION

The lack of physical activities can increase the likelihood of chronic heart diseases, diabetes and high blood pressure [26]. Prior work in the area of personal informatics [9,14,31,34,35] has shown that technology can play an important role in improving peoples' health and wellbeing. As a result, researchers have focused on encouraging and motivating people to make better dietary decisions [12], monitor their sleep [15], understand health-related behaviours and patterns [14], and to be more physically active [7]. With the emergence of technologies such as wearable activity sensing devices (e.g., Fitbit, Nike

FuelBand), the focus of researchers have shifted to understanding the effects of long term use of these devices [11,5,29]. Furthermore, studies have also focused on finding ways to better represent data collected from these devices so that the users can meaningfully understand their own data [14].

Although people spend a good amount of time in their workplaces, the application and use of activity tracking systems within workplace settings has been relatively less studied within the human-computer interaction (HCI) literature (with a few exceptions [10,11,22,23]). In particular, the sedentary lifestyle afforded by workplaces is a concern for employees' health and provides opportunities for HCI researchers to design and develop technologies that can encourage people to be more active. Studies in public health research have argued that 10,000 daily steps can support healthy lifestyle in adults [36]. However, attributes of workplace settings such as productivity drivers, long working hours, and work ethics may affect decisions about undertaking additional physical activities.

There are opportunities and challenges around exploring the role of activity trackers in workplace settings. One the one hand there is an attempt to reduce and manage interruptions [3,38] at workplaces to improve efficiency; while on the other hand companies encourage their employees to be part of employer sponsored health and wellness programs to create a healthier work environment. Prior research has shown how employees can integrate their working hours with breaks, during which they can undertake personal tasks without compromising their work efficiency [33]. There has been some initial work [6,10,11,37] on understanding the experience of simple step-counters as a part of employer-supported health and wellbeing programs. Such studies have shown that rather than prompting behavioural change, using simple pedometers can promote health benefits by encouraging self-reflection [10,11,37], and step counting becomes a socially-negotiated activity [10,11]. A major criticism of existing workplace-based activity tracking wellness programs has been that they are designed with a 'techno solutionist' mindset [22]. As Masson et al. [22] contend that fitness is not a problem that can be solved through activity tracking devices such as Fitbit and smartwatches alone. In particular, for people with highly distinct lifestyles and needs, such wearable devices do not offer sufficient adaptability and flexibility to suit diverse and complex workplace settings.

The purpose of this paper is twofold. It first aims to understand employees' perceptions and existing experiences associated with activity tracking in workplaces. Secondly, it aims to investigate how we can design activity tracking systems to suit workplace complexity, social dynamics and everyday routines of employees. To this end, we carried out a user-centred design process involving our own university environment, in order to seek opportunities to develop and trial an activity tracking system. Our design process was divided into three phases: 1) Initial interviews and observations from an existing employer-supported wellness program; 2) Two participatory design workshops for generating innovative ideas for activity tracking systems; and 3) Implementation and a preliminary field trial of a prototype activity tracking system.

In Phase 1, we carried out a study along with an employer-supported wellness program that our own organisation was participating in. At the end of a 100-day wellness program, we interviewed 17 employees who participated in the program and learned about their experiences. We derived design implications from this phase. In Phase 2, we carried out two participatory design workshops, involving ten employees. The aim of these workshops was to understand employees' perceptions about physical activities and explore

ideas for designing an activity tracking system suitable for workplace settings. Using the insights from both the phases, we implemented a prototype activity tracking application called QUTgo that runs on Android-based phones. We ran a preliminary field trial with eight participants over two weeks, where we conceptualized QUTgo as a 'technology probe' [13] with an aim to gather social and technological insights into further design iterations. Our findings show that the 'one-size-fits-all' philosophy inherent into the existing activity tracking systems does not work well for people with different needs and workplace routines. Our prototype application, QUTgo, is designed by taking our university's infrastructure into account, enabling employees to integrate with their work routines and promoting social interactions among the employees.

The contributions of this paper are twofold:

First, it presents a grounded understanding of employees' perceptions and experiences around physical activities in workplaces and the use of activity tracking systems. It shows how employees carefully interweave their physical activities within their everyday routines. Second, the paper presents a design approach, which shows that it is important to consider work settings and employees' everyday work practices when designing activity tracking systems. It also shows that activity tracking systems should go beyond simply displaying the step-count as a measure of health, and use step-count as a currency of engagement to enable social interaction around activity tracking.

## 2 RELATED WORK

### 2.1 Activity Tracking and Technology

A lack physical movements can lead to health risks such as diabetes, chronic heart diseases, high blood pressure and obesity [26]. Studies have shown that while a "moderate-intensity physical activity" for around 30 minutes per day would be sufficient to prevent obesity, being motivated to continually perform at this level poses a significant barrier [26].

In the past decade, research within HCI and Ubicomp areas have seen a growing interest in exploring the use of activity tracking devices for supporting healthy behaviours. It has been argued that personal activity tracking devices can play a major role in motivating users to do more physical activities by regularly displaying their fitness data [30, 31]. While there are various types of activity tracking devices, most of them are used for fitness and health-related topics such as weight management or training [31]. Studies have shown that numeric values such as step counts and calories used are more interesting to users than the actual activity they performed [11, 36]. Tudor-Locke & Bassett [36] report the importance of step counting and provide metrics to identify an active person. They claim that a person who walks 10,000 steps per day can be considered as a healthy person while a person with 5,000 or less can be classified as a person with "sedentary lifestyle" [36]. Nonetheless, some query the accuracy of the numeric values such as step counts, claiming the numbers vary from device to device [11]. Fritz et al. [9] report that metrics such as step counts can only motivate users initially and that motivation tapers off, which is one of the reasons why people stop using these devices. Therefore, they recommend that the systems should be able to adapt as the users become more active. Other reasons for the decline in activity tracker usage include expense, variable quality and lifestyle shifts [8]. They also claim that people stop using these devices since

they had high hopes in the beginning but could not see a positive impact soon enough. However, Shaw et al. [32], report that even though the users stop tracking their activities, their behaviours and attitudes towards fitness were changed and they adopted new routines to their day-to-day activities. Rooksby et al. [31] state that people use different tracking applications only for short durations, with their primary goal being to change their behaviour towards fitness and health in the future. Researchers agree that there needs to be an appropriate presentation of tracking data to motivate users to keep using the devices [9] and cater for different degrees of willingness to continue fitness activities [5,16].

A study of individuals who are grouped according to their willingness for carrying out physical activities has shown that it is the people with a medium level of willingness are more likely to be motivated to use activity-tracking technology [16]. Maitland and Siek [21] claim that along with technology interventions, people need to be educated. They further suggest that user interfaces (UIs) need to be revealing and customisable. Extending this work, Burns, Lueg, and Berkovsky [5] have explored ways of creating UIs to encourage and motivate people. They have reported that "low-complexity, low-engagement" UIs, which require fewer user interactions, are better at motivating users than UIs with "high-complexity, high-engagement", which require a high level of user interaction. Progressive engagement is identified as another important motivational factor in UI development [36].

Lin et al. [16] claim that any activity tracking system should focus on providing positive feedback. Positive feedback can keep users motivated while reducing the risk of losing user interest. Fritz et al. [9] report that users should be able to find other users with similar fitness goals and requirements, to sustain motivation in the long term. They also claim that the users need to be continuously aware of physical activity data of themselves as well as their peers to be motivated. Sharing information related to activity tracking among friends has also shown to be providing reflective insights and further motivating [1,19].

In summary, the existing literature on activity tracking has focused on issues such as the importance of appropriate UIs to support better sensemaking, long-term engagement, sharing of data as a motivational factor, among others. None of the studies above have focused specifically workplaces, which is the main focus of this paper.

### 2.2 Work environments and Activity Tracking

It is only recently that we see the focus on activity tracking devices in workplace settings. For example, Vyas et al. [37] describe their study of a pedometers used in a workplace-based health and wellness program. They found that activity tracking was socially-negotiated and participants put in a good effort to reach the milestone of 10,000 steps per day by changing their behaviour in work environment such as walking instead of taking the bus or using the elevator. They also found that by asking participants to enter their daily steps manually into a system allows the users to reflect on their daily activities. This is an impact which is harder to measure in an automated system. Masson et al. [22], on the contrary, brought out critical aspects related to a workplace-based health and wellness program. In their study, they found that several participants were frustrated during the course of the study due to privacy concerns, a lack of personalization and clarity on step count data. Mathur et al., [23] have studied the employees' experiences of interacting with a quantified workplace system. They have defined two types of sensing: *participatory* that refers to activities which need direct input from the user, and *passive* that refers to the activities which give quick and automated information. The researchers claim that both passive and active sensing has to

be considered in the right balance in a workplace setting. Their explorations have revealed that while the aspects of passive sensing are needed for initial engagement of users, participatory aspects could help develop a more long-lasting sustainable use.

Gorm and Shklovski [10,11] report that activity tracking applications have to be treated with caution in a work environment since many employers have raised concerns about the amount of time users spend with activity tracking instead of working. However, Mathur et al. [23] claim that this negativity can be reduced by combining the data collection progress with daily habits such as brewing a coffee or waiting for the printer. Skatova et al.[33] have identified that such activities can be used within mini breaks such as coffee breaks instead of just "wasting" the waiting time. They concluded that the ubiquitous sensor technology could be used by designers to integrate the activity tracking with daily routines at workplaces.

However, it has been argued that tracking activity may lead to privacy issues as many of these activity trackers collect data. While these data can be used by the users in the reflection of their behaviours and improving their lifestyles, for an outsider, accessing this data could allow monitoring of users' personal lives, as it records their daily routines and patterns [29]. Privacy concerns also differ widely between different environments and the kind of data that is stored by the tracking device [28].

In summary, while the above-mentioned studies focus on workplace settings, the participants here mainly engage with employer-sponsored programs where simple pedometers are used. There is a clear need to explore thoughtful designs for activity trackers that considers participants' perspective and their everyday routines.

### 2.3 Social experience and playfulness

Positive social experiences can strongly influence behaviour of user using activity tracking applications [27]. They can be used to motivate users to keep using activity tracking applications over a longer period [31,37]. Maitland and Chalmers [20] showed that peer involvement was one of the major factors for continuously using activity trackers. They also report different levels of peer involvement such as passive, supportive or proactive can encourage users at different levels. Fritz et al. [9] have found that people prefer to share their activity data via social networks and that is a critical motivational factor for them. Furthermore, by including social network sharing abilities to an activity tracking application helps to spread the message of healthiness to a broader community and inspire more people to be healthier [4] . However, the same social presence can have an adverse effect as they can cause a feeling of being harried or pressured [11].

The inclusion of playfulness is also a strong contributor to the acceptance of activity tracking applications [23], as competing with peers can motivate users and increase their engagement with the application. Game elements can also be used to alter the behaviour of users and guide them towards a specific topic without exerting pressure on them [4]. It also helps to convey a fun environment to the user and detach her/him from the formality of work processes [17]. Rooksby et al.'s [30] showed that collaboration and competition across and within teams can add playful elements in activity tracking applications. Mueller et al., [25] suggest that physical activities such as walking and running need to be done together instead of in competition with each other, which can be seen as a positive means of user engagement through social connections.

In summary, the above-mentioned studies show a great potential for using social interactions in the design of activity tracking systems. We aim to draw inspirations from these studies in designing our own activity tracking system.

## 3 DESIGNING A WORK-PLACE BASED ACTIVITY TRACKING SYSTEM

In order to better understand the potential of activity trackers in workplaces, we undertook a user-centred design process in three phases. In the first phase, we carried out a study where we investigated the experiences of employees who participated in an employer-sponsored health and wellness program. Following this, in the second phase, we carried out a set of participatory design workshops involving our university's employees, where we co-designed high-level ideas and concepts for developing activity tracking applications. In the third phase, we implemented a prototype activity tracking mobile application called QUTgo that runs on the Android platform and gathered insights from a small-scale field trial in our university. The goal of our design process was not to develop a definitive, fully-fledged activity tracking application; instead, we aimed at gathering insights at different phases of design. Our implemented prototype QUTgo was treated as a 'technology probe' [13] to learn about employees' perceptions about physical activities and the role of activity trackers in workplace settings.

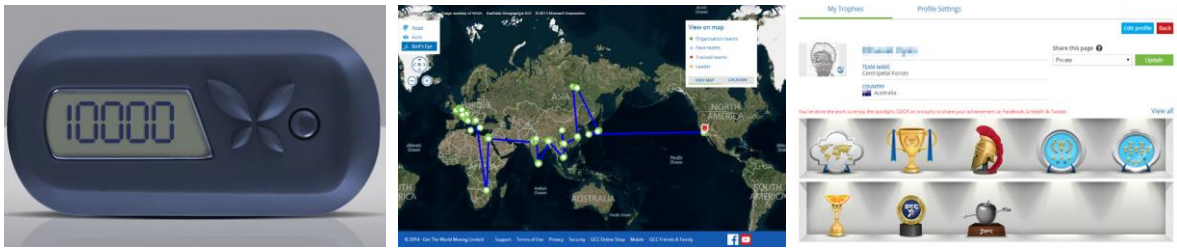
We aimed to develop a grounded understanding of people's perspective on the role physical activities play in workplaces and what their existing experiences are with regards to the use of activity tracking systems. We believe that by studying people's experiences of participating in a workplace-based health and wellness program (Phase 1) will enable us to understand the role of activity tracking systems play in a workplace and how they fit into its social fabric. Unlike the one-size-fit-all approach used in the existing activity tracking systems (e.g. FitBit), we aimed to involve users in the design of new activity tracking system using a participatory design approach (Phase 2) to bring out issues that are important for users. Our design process aimed use findings and learnings from the first two phases of our design process to inform the design of a prototype activity tracking system called QUTgo. In Phase 3, we ran a smalls-scale field trial of QUTgo understand the experiences supported by it.

Our research was centred around our own workplace – Queensland University of Technology in Brisbane, Australia. The university had two major campuses in Brisbane, however, we focused on the Gardens Point campus that was in heart of the city. The campus had 26 buildings in close proximities that were name A to Z. Being familiar with the setting ourselves, we were aware of the different facilities around the campus such as food courts, bank ATMs, cafes, library, among other things available at different buildings. As an academic or an admin staff member, one routinely goes around several buildings during a regular day to get things done. We believed that the setting where there are geographically-dispersed buildings will provide a good opportunity for us to conduct research on activity tracking. All the three design phases took place during three consecutive academic terms, starting from August 2014. Our target participants were university employees – mainly academic, and admin staff members. Across the three phases of design, we aimed to keep similar type of participants.

### 3.1 Phase 1: Observations from a Wellness Program & Initial Interviews

Every year, our university participates in a health and wellness program called the Global Corporate Challenge (GCC)[1], which runs over a 100-day period [39]. GCC is a global initiative where large organizations and corporates participate with the aim to create a healthier work environment. Companies subsidize their employees' participation. Employees can choose to participate in a team and are provided with a wearable step-counting pedometer (Figure 1a). Participants are asked to wear the pedometer throughout the day. At the end of the day, they are required to enter the total number of steps to a web-based system. The web-based system ia used to track the progress of users over the 100-day period. It also generates graphs which can help them set targets. Aligning our research with an ongoing program such as GCC was an opportunity for us to not only recruit appropriate participants, but also understand the experiences of employees that can help us inform the design of a novel activity tracking system.

GCC's web-based system had several gamified features to motivate participants. For example, participants' navigations are mapped onto an interactive world map (Figure 1b) based on her/his step counts as a motivational element. Users get trophies as rewards for reaching certain milestones (Figure 1c). They can also see their standings in leaderboards which allows users to compare their progress with other teams. An individual participant can also challenge other members or teams for several user-defined milestones. Since studies have shown that an active person should target around 10,000 steps for a day [32], the GCC program also recommended the participants to have a similar aim.




(a) (b) (c)

**Figure 1. Pedometer (a), interactive world map (b) and trophies page (c).**

#### *3.1.1 The Study*

People who were taking part in the GCC in 2014 from our university were recruited via emails for our study. We conducted the study with seventeen participants whose ages ranged from 34 to 61 years. There were nine male and eight female participants. Out of the seventeen, fifteen participants were full-time university employees while the other two were part-time workers; and twelve were academic staff and five were admin staff members. A semi-structured interview session was arranged with individual participants, which lasted for 45 minutes. We carried out interviews one week after the GCC's 100-day journey.

The interviews were built around questions which helped the participants reflect on their overall experiences. In particular, the question categories included participant demography; their motivation to take part in the study; their daily practices and routines; and any other social aspects related to the study.

[1] GCC has now been rebranded as Virgin Pulse Cooperate Challenge.

The interviews focused on understanding participants' overall experience of participating in the health and wellness program. We audio recorded all the interviews were made and data was analysed, coded, and themes were formed. These themes were used to provide insights into the health and wellness program experience. Results of this study are reported in [37].

### *3.1.2 Findings of Phase 1*

Our findings suggest that the participant's overall experience with the study was positive. While our participants stated different motivational reasons, most claimed that they were interested in tracking their fitness and lead a healthier lifestyle. However, a few participants were influenced by their friends to join a team in instances where they needed more members. With regards to the social aspects, much of the social interactions between the participants happened by viewing their own and other teams' performance on the web-based system. There were several instances where participants discussed their experiences with one another around their step count and physical activities.

There were a few instances where a participant forgot to wear their pedometer or enter their accumulated step count to the system. Some participants lost their devices, but were able to use their spare one, or borrow one from another team member. Many participants discussed how they undertook extra exercise or activities to increase their daily steps count, such as walking up or down stairs instead of taking an elevator. Motivation levels did drop for some participants when teaching started. Participants mentioned that they learnt about their everyday patterns of exercise and could identify throughout their day if they were going to reach their step goal or not.

In the following, we discuss specific details of about findings.

#### *3.1.2.1 Steps and Employee Routines*

Participants reported that they frequently incorporated simple physical activities which would increase their daily step count. This included, among other things, using stairs instead of elevators and taking longer routes to reach to their destinations. Some employees parked their cars further from the university and a few disembarked busses one stop earlier so that they can walk more and accumulate more steps. It was clear that participants were making sure that they use all the possible opportunities to increase their step count; however, they were very cautious to make sure that they do not spend too much time on such activities. Hence, many of the longer walking activities happened when they entered and exited the university, and while they were at the university shorter walking activities took place.

The work took priority over accumulating extra steps, especially when there were work deadlines and shortages of time. An important finding of the study was that it helped the participants identify their daily routines as well as highlighted some of their (in)activities. Participants were often able to associate a highly active day with high step counts. For example, one of our participants, a part-time working mother, indicated how her steps count would vary based on her kids' activities. She commented about her step counts getting increased when she had to make her kids ready, prepare lunches and drop her kids off to school. While during the weekends she would see her step counts dropped drastically as the kids where with her all the time. Participants also felt that while they participated in GCC, the step count on the pedometer always reminded them about achieving their 10,000 steps goal. The following is a comment from one of our participants:

*"I was a bit more conscious on how much I moved. There were some days that I was sitting down all day and I know I had done only 3000 steps. I know I am not moving enough. You always know you got to do about 10,000 steps a day to be active. I realize that jeez I am not doing anything. That became important to me to make sure that I did do some movement throughout the day. I need to move."*

One issue from the above example that came out strongly was the motivation of accumulating at least 10,000 steps (as recommended by the GCC program) by the end of a day. It was less likely for participants to have taken 10,000 steps in their workplace alone; in fact, most participants mentioned that they had more flexibility to accumulate steps when they were outside of the university. Participants would end up modifying their behaviour to reach their 10,000 steps milestone in the evenings at their homes. Some participants created routines at home where they walked with their spouses to add more steps. One of the participants reported that if she is missing a few hundred steps by the night, she would find something to do in the house where she would do ironing or prepare lunches for her children. She commented:

*"You will do everything to catch up with the steps. When you are at home, instead of going up the stairs once to get all the things you need, I will do that multiple times – going up there again and again."*

*3.1.2.2 Sociality of Step Counts.*

As the online system allowed the participants to see how their team members were doing, the GCC program had a strong social element. Although the recommended daily target was 10,000 steps, the step counting was more of a negotiated quantity rather than a hard target. For many participants, it was not possible to achieve the 10,000 mark in a typical working day. One of the participants said during the interview process,

*"In my first couple of days experience, I saw that I was not reaching 10Ks. But when I saw how my team mates were doing, I thought I was actually doing alright."*

While the GCC program recommended 10,000 steps per day, the actual target was socially negotiated between team members. We saw that some teams had an internal target of 12,000 steps per day (overriding the recommended steps in a day), whereas other teams didn't believe in such targets, which made the team environment less competitive. A few participants did raise a concern about getting to 10,000 steps marks while being at the workplace. As the system allowed team members to see each other's step count, they did express surprise when a fellow team mate had acquired more than 10,000 steps. They expressed that the GCC program did not allow a level playing field, as many participants were seemingly acquiring step count outside of their working hours. Others did recommend that that health and wellness program be made more workplace centric, where only the activities that are happening at work are included.

Three of the participants mentioned that their teams did have some rules and structures around their participation in the health and wellness program. Two participants mentioned about being part of 'walking meetings', where GCC team members (who were also colleagues) would together walk around the university campus and talk about their projects and research activities. One of our participants organized walking meetings within her team where members would walk around the university during lunch breaks [37]. The participant commented:

*"It was nice getting together with work-mates and walk, instead of getting a coffee or going to a meeting. I guess, it was nice to walk and talk. It feels personal like you get to know the person a little better."*

The above quote suggested that the participation in the program enabled people to indulge into social activities during their work hours. We also found that many participants were being "opportunistic" in way to incorporate physical activities into daily routines; sometimes they would even create calendar entries to organise group walks. The participants explained these type of activities as "incidental exercise", which allows them to interweave their social activities with our study so that they can resourcefully increase their step counts.

*3.1.2.3 Steps as a Lens into People's Lives.*

As opposed to Fitbit and other activity tracking devices, the pedometer that was used in GCC (at the time of the study) did not allow automatic uploading of steps hence participants had to enter their steps everyday manually. At times, the participants did mention that this was quite cumbersome, as they had already been using devices like Fitbit that would automatically register the daily step count. However, the interpretive flexibility afforded by the pedometer and the light-weight social networking features of the online application of the GCC allowed participants to reflect on their day to day activities as well as habitual practices. One participant explained the overall experience as;

*"The number does make you aware that you do need to do more and get more active. In the afternoon, if the number is not there yet, you know you do need to do more to keep it. When you do a 2-hour lecture, you can pace up and down so you can get more steps."*

The process of entering steps into the system, made the reflection too explicit that it provided a way for participants to think about their regular routines. During the time of our study, we realised that the participants developed a strong familiarity with the process of step counting and began to plan their everyday physical activities accordingly. They could target specific step count by specific time in the day. For example, one participant mentioned that he would make sure to achieve at least 7,000 steps before he left work. He commented:

*"If you drive, you know how few steps you make. You are losing the steps. It shows you that driving is not good for you. If you park further away, you got to walk."*

This showed the efforts participants made to change their behaviour to make sure that they accumulate a certain number of steps per day.

*3.1.3 Design Insights*

Our findings from phase 1 showed that an activity tracker which is designed to promote physical activities at workplaces should enable flexibility and let participants interweave activity tracking with their everyday work routines. It was apparent that many participants found time outside of the work hours to reach to their 10,000 steps goal. New activity trackers should be designed to enable adding small scale physical activities during work hours. We also found that social engagement is a critical aspect for promoting activity tracking in the workplace and social elements such as discussions, challenges and competitions should be incorporated to a new activity tracking application.

### 3.2 Phase 2: Participatory Design Workshops

To further our understanding of the potential of supporting physical activities in workplaces and exploring initial ideas for designing a workplace-based activity tracking system, we organised two participatory design workshops involving ten participants.

*3.2.1 The Study.*

We organised two participatory design workshops over a course of two weeks, involving ten participants (five in each workshop) who were working in our university at the time. These participants knew about the GCC program that our university was involved in and eight of them had participated in the GCC program previously. The workshops were organised to in two sessions. The first session had four academic and an admin staff members and the second session had three admin and two academic staff members. The first session was aimed at understanding employees' existing practices and perceptions of physical activities in the workplace. We initiated the session by asking them to discuss physical activities they do at the workplace and asked them to elaborate. We asked questions related to how they can increase your step count within the university without compromising their work and explored what would be a 1-minute activity for them. Using the issues that immerged from this session, in the second session, we asked our participants to generate ideas for incorporating technology that can provide engaging experiences while supporting activity tracking. Figure 2 shows the overall setup of the workshop (a) and an example design idea generated from the session (b).

**(a)** **(b)**

**Figure 2. A participatory design workshop session (a), and a resulting design concept where a virtual zombie triggers participants to walk around the campus on a specific route (b).**

Both sessions lasted for an hour making the workshops a two-hour-long activity. All ten participants were full-time members of the university and ranged from academic, administration and research staff. Two researchers and a full-time master's student moderated the workshops. The audio from both workshops were recorded.

*3.2.2 The Findings of Phase 2.*

From the initial group discussion, we learnt that walking around the campus was one of the main physical activities our participants did. Going in and out of different buildings for meetings, walking to lecture rooms, buying lunch and beverages from cafes and taking small breaks to have water or use restrooms

were a few examples of physical activities that involved walking. In the following we discuss some highlights from both the workshops.

*3.2.3 Work and Physical Activities*.

It was clear in both the workshops that only walking would be a sensible choice in workplaces that can be supported through an activity tracking device. One of the participants said,

> *"I think we got to make sure that we're targeting the right sort of physical activity, because the marginal increase in activities may not be great for their health. But if you can get people to exercise enough to get some sort of meaningful outcome, not so much as sweating because you don't want that at a workplace. But something like steps would do better. If it's steps then, it's lot harder to go up the stairs than just walking on the campus. If we are aiming for an activity tracking tool than it can't just be about who gets the most steps either."*

Participants also wanted to make sure that if it is a workplace-based activity tracking system then it should focus mainly on office hours. One participant who also had previously participated in the GCC program (but did not take part in our study) had the following comment:

> *"Problem with GCC was that it's all encompassing, and people who are already fit will do more that 10,000 steps in the evening. This needs to be more level-playing field where you only count their steps during the work hours within the campus."*

Participants also suggested that it is important that any activity tracking system is non-intrusive in nature and should allow employees to interweave it in their everyday work routines. During the second session, participants came up with several design concepts and one of them was titled "Zombies All Around!" As can be seen in Fig 2b, the main idea of this concept was that at a certain point in time, a virtual zombie comes close to an employee's office and in order to earn points that employee needs to go to another building in the campus using a specific route. On this concept the workshop participants had the following discussion:

Participant A: *"Why don't we have random pop-up zombies on our PCs that says "Hey, you gotta go for a walk!" It doesn't happen to everybody at the same time, because that would be the loss of productivity. But if you could do that randomly that could work."*

Participant B: *"If I get a zombie pop-up, I would just ignore it."*

Participant A: *"But when you can't do anything on your computer, you know!"*

Participant C: *"That is going to be a disaster, if my computer is suddenly frozen."*

Participant D: *"It needs to be an opt-in sort of thing, rather than a company-wide thing."*

The above conversation showed that participants preferred an opt-in approach where they could initiate the activity based on their situation. Participants suggested that walking as a physical activity was predominant in their existing routines. Hence, for them to do any additional walking would require strong triggers. Here participants discussed different reward mechanisms ranging from getting coffee or meal vouchers to getting a wider recognition within their teams. Following on the aspect of receiving recognition, one of the participants suggested that if employees can stop taking elevators and walk up and

down the stairs a reward can be: *"It may also co-opt with others and say employees on floor-2 have saved this much electricity which is much tons of $CO_2$"*.

Another design concept that was discussed in another workshop was inspired by The Amazing Race game. In the following, we show an excerpt of the discussion that took place during the workshop:

Participant A: *"Look at the amazing race game. We can think about similar thing here at the university. People get points for walking around different buildings. You get an option of, for example, getting five points if you choose a longer route and one point if you choose a short-cut. And the one, who builds the most points at the end of a week, gets a prize at the end of it."*

Participant B: *"So, not points for taking the elevator but ten points for taking stairs."*

Participant C: *"If we make this in a way that people are relying on each other so that they feel there is a sense of accountability."*

Taking longer routes to different buildings and enabling employees to take extra steps to accumulate points came out very strongly from the workshop discussion. Making people accountable by enabling group activities was also an important point of discussion. We wanted to make sure that the design concept is non-intrusive in nature and allow them to easily integrate physical activities in their daily routines.

**Design Insights:**

Our findings from phase 2 showed us that a new activity tracker design should first develop an understanding of the several types of physical activities conducted by employees in their respective workplaces. The new activity trackers should then focus on supporting those activities instead of introducing new ones which may hinder the work practices. We understood that step counts may be an effective way of motivating our coworkers over any other physical activity. The application should also allow the users to accumulate scores by performing more challenges as well as walking extra steps. However, it should also allow the users to opt-in/ opt-out from the challenges according to their preferences.

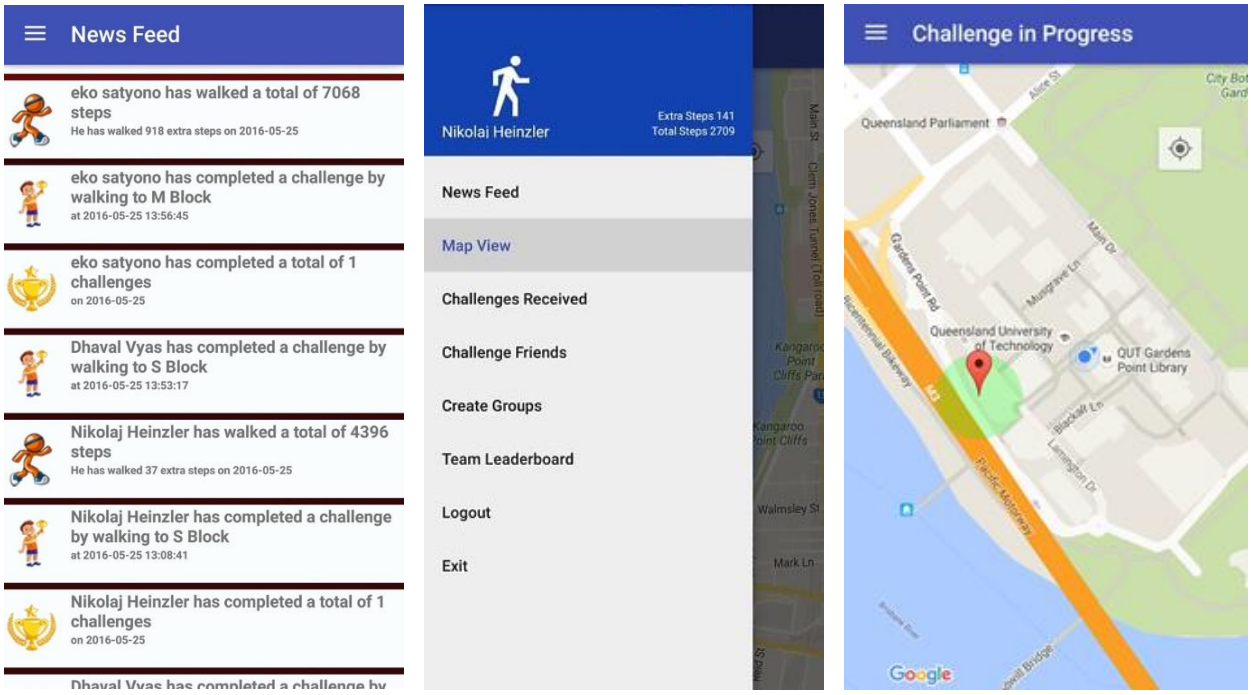
### 3.3 Phase 3: Implementation and Preliminary Trials

By utilising findings from the previous stages, we implemented a prototype mobile application called QUTgo that supports activity tracking within our workplace. We treat this prototype as a technology probe [13] to understand its use in a real-world workplace setting and the experiences it enables for employees. In this section, we discuss the design of QUTgo and describe its small-scale evaluation and some preliminary findings.

#### *3.3.1 QUTgo – A prototype activity tracking system.*

QUTgo is an Android platform based mobile application (see Figure 3). It is a location-based application that integrates physical infrastructure such as buildings of the university campus in its design. Our university campus has 26 buildings within a close proximity, which are named from Block-A to Block-Z. The main functionality of the application is that it encourages employees to take longer routes when they walk to and from different buildings on the campus. When a member leaves a building he/she receives a challenge on the app to walk to a specific building on the campus. As can be seen in Figure 3c, when a member gets a challenge the application shows the target block in a green circle. Once a challenge is

accepted members can choose any path to go to the block where a challenge is pointed. Employees can choose not to continue with the challenge if their work schedule does not allow this.




**(a)** **(b)** **(c)**

**Figure 3. QUTgo App. The main screen displaying updates (a), menu screen (b) and screen displaying an ongoing challenge (c). A demo video of QUTgo app can be viewed here: https://www.youtube.com/watch?v=V6NsrT75ksY**

The application uses Android's *Geofence* feature, which allows the application to monitor employees entering or exiting specific building wherever these geofences are placed. The geofences are hardcoded onto all the 26 buildings of the campus. As the application is meant for supporting unobtrusive interactions, it never sends a challenge when employees are inside a building. It works on an assumption that when members are inside a building they are unlikely to accept a challenge to walk to another building. Only when the application detects that a member has left a building, it triggers a walking challenge, where it is much more convenient for the member to accept (or reject) and complete a challenge. Before accepting a challenge members can see how far they have to detour to get to their original destination (Figure 3c). When a user completes a challenge, the application shows the number of extra steps the user has added to their daily step count. These extra steps are calculated based on the number of steps a participant accumulates during a challenge. The app also shows the total number of steps per day on the main menu (Figure 3b) along with other features of the app.

QUTgo supports several social features. Members can create groups or add individuals to their friend list. Within teams, members can create group-based challenges; and individual employees can also send walking challenges to others. Members can challenge others to go to specific buildings, where they can add a short, personalised message. If they accept the challenge then they have 20 minutes to walk towards the destination. QUTgo allows members to create group challenges, such as, setting up a goal of 5000

extra steps, where all the group members can contribute. The leaderboard feature lists of members based on their number of extra steps taken during the day. The application starts with newsfeed (Figure 3a) where specific achievements and updates from friends and group members are displayed such as a friend completing a challenge or reaching a particular milestone.

The application gets refreshed daily and shows daily activities of members on its newsfeed screen. Members can browse the history of their performance over 2 weeks.

### *3.3.2 A small scale field trial.*

Although QUTgo was fully functional, our aim in the design process was to use it as a 'technology probe' [13] in order to learn about employees' perceptions towards physical activities in workplaces and use their feedback in following design iterations. Hence, we did not carry out a fully-fledged trial of QUTgo; instead, we ran a small-scale field trial involving eight university employees. These participants were recruited as two groups of four participants – one with academic and another with admin staff members, since we aimed to probe the social aspects of QUTgo. While we desired to involve the same people, who participated in the earlier studies, some of them could not join due to their unavailability while others did not fit into our requirement of being part of a pre-existing social group. We wanted to make sure that our participants knew each other well so that we could explore the social side of QUTgo. While only two of the eight participants had previously participated in the earlier study, all of them were aware of the GCC program and were interested in using an activity tracking application.

Following an initial demonstration of the application, we asked these participants to use QUTgo over two weeks and invited them to individual interviews at the end of the trial. The interviews lasted for 45 minutes where we aimed at understanding participants' overall experience with QUTgo.

### *3.3.3 Findings*

#### *3.3.3.1 Overall perceptions.*

The participants appreciated the overall idea of QUTgo and saw it as a relevant activity tracking application in their workplace. In particular the idea of walking and completing challenges was well appreciated:

> *"I like the nature of challenges. It makes a boring task, such as walking around the campus, more interesting and fun." "I like the idea to engage people to be more active, because we sit a lot in front of our laptops."*

In the following, we present some highlights of the field trial.

#### *3.3.3.2 Workplace Routines and Localization.*

QUTgo was designed keeping the university's infrastructure in mind. The participants saw QUTgo as a suitable activity tracker within their workplace. In particular, the unobtrusive nature of QUTgo was seen as a positive aspect. One of the participants said,

> *"You are already going out to do something, you are already mobile. So, instead of going through a direct route you take a longer route."*

The use of QUTgo allowed a convenient way for participants to be part of a challenge when they were already outside and unlikely to be immersed in any work-related activities. Participants could opt-out in cases when they were too busy or did not want to be a part of a challenge. Most participants made use of QUTgo when they entered and exited the university campus and went out to buy lunch or coffee.

*"I liked using it during my lunch time, because there I have time to walk and complete challenges. […] It motivates me to walk different ways back to the office."*

To some participants, QUTgo was perceived as a break-time activity-tracking technology, as they used it mainly when they were out to buy lunch. Participants also appreciated the localisation supported in the application, as the walking challenges were named after different buildings in the university campus. As the design of QUTgo was driven by the specific setup of university, it made the use of the app familiar and easy to learn.

*3.3.3.3 Social aspects.*

The social experience supported by QUTgo was seen in a positive light. The possibility to connect with colleagues was described as motivating. Participants extensively used the feature where they could challenge others in the group:

*"Challenges with friends are a good motivator and they add some game elements to the application. I really need that kind of things to get motivated."*

Several reasons were given around why participants offered challenges to others. At the beginning, most of the offered challenges were just for testing the application. After that, all participants described that it's a good way to meet people. The messaging function was also used to send specific messages, such as: "time to go to lunch"; "Hi Alex, meet me in M block"; "B block, on your way home". As QUTgo made the group members aware of participants completing challenges, such messages became meaningful to them and participants took them seriously.

The participants also stated that competition with other users added a new motivation part to the application and it makes the whole progress of being active more joyful. The participants felt that the Newsfeed page, which always opens first, gave them a good overview over the activities of their friends. They used this information to compare themselves with others and to see if they have to do more or not. They said that they used the activities from other participants as a baseline for themselves. The leaderboard was also used for comparison with the rest of their group.

*"Seeing what my friends have done was really cool. I could always check if I have to do more, because I don't want to be the most inactive person. […] I think that the competition pressure is positive, because it increases my personal activity level."*

There were a few examples where participants increased their step count beyond that suggested by the challenges. In one example, a participant reported that while he was experimenting with the application he was able to accumulate more steps by not going directly to the building where he was challenged to go. Instead, he would walk around different buildings for a few minutes to accumulate extra steps and then eventually complete his challenge. This way he was able to be on the top of the leaderboard. Another

participant mentioned that he would intentionally challenge his colleagues so that they have to walk a lot as a punishment:

*"Just to be nasty. I want to let my colleagues walk longer ways, especially when I knew where they are and where they have to go".*

*3.3.3.4 Improvements.*

A few participants stated that the challenges were easy and that they were likely to get bored with them after a while. Out of 8, 2 of the participants stopped using QUTgo in the very first week, as the novelty aspect wore off:

*"[..] It should be more than just walking to blocks. After you've done a couple of challenges, it got really boring and I stopped using it."*

Some participants did give suggestions about adding more gamification features such as adding drawings or photos of the places so that they can leave their digital footprints.

## 4. DISCUSSION

In this paper, we described a user-centred design process that we applied in developing QUTgo – a workplace-based physical activity tracking system. We have presented one design iteration, and our future plan is to carry out another iteration utilizing the findings from our initial field trials. However, each of the three described design phases has contributed towards the improvements of the current version of QUTgo.

To our knowledge, this paper presents one of the earliest attempts to design and develop a novel activity tracking system for workplaces involving users in the design process. While earlier studies involving activity tracking used already available tracking devices such as FitBit, Jawbone Up, Nike Fuelband and smartwatches to study a wide range of phenomena [9,18,31], there was a limited understanding about how one can design personalization, and adaptation to users' existing situations. The recent attempts [6,10,22,37] into studying activity tracking systems in workplaces also use pre-existing devices. Masson et al. [22] have criticized the use of one-size-fit-all type activity tracking systems as these do not fit into the lifestyle of everyone who use such systems. Our work has drawn inspirations from such studies and has built one their criticisms to design activity tracking systems that take into account users' routines and infrastructural setup of workplaces.

### 4.1 Situated and localised nature of workplaces

Activity tracking devices such as FitBit were introduced as ubiquitous tools that everyone can use. Such devices are criticized for their marketing approach [22], where it is assumed that all people have similar kind of needs and motivations. It is clear that people do not automatically become healthier by wearing activity tracking devices as there needs to be engaging experiences supported by the devices. As some of the earlier studies [8,9] have shown that even though there will be an initial interest for among everyone to use these type of devices, their interest will decrease over time. Morozov explains (cited in [22]) that this is a phenomenon that occurs due to "technological solutionism" [24].

The situated nature of workplaces is challenging to design for. However, companies continue to motivate their employees for continual self-improvement in health, while presenting their concerns about their sedentary lifestyles. Literature [2,20,21] has shown that physical activity tracking is a suitable way to motivate novice users to transform their lifestyles into a healthier one. However, a common criticism of activity trackers used in workplace-based health and wellness programs has been that 'one size fits all' approach may not incorporate workplace complexities and could mismatch with employees' everyday routines and their overall perception of physical activity in workplaces [22]. However, we believe that there are individuals who have a genuine interest towards changing their daily routines to a healthier one. One of the main objectives of our explorations was to figure out a way to design an application that helps the university employees to break the sedentary workstyle at the office and motivating them to keep using it for an extended period of time.

Therefore, as an initial step towards this endeavour, we carried out an exploratory study with 17 participants to determine whether step counting is motivating for of activity tracking. Our participants tracked their steps using pedometers for a period of 100 days. The results suggested that step counting in the workplace can be used as a useful motivator. To deepen our understanding regarding the current walking practices of our employees, we have conducted a co-design workshop where the participants contributed design concepts.

Depending on their roles, our university's employees often leave their building for attending meetings, buying lunch and beverages, among other things. The design of QUTgo aimed to tap into these everyday practices. While on the one side, QUTgo focused on motivating university employees to walk on longer routes than usual, in the design of QUT, we emphasised heavily on not making QUTgo a burden (e.g. forcing users to conduct physical activities) and not hindering office-based work. The learnings from the first two phases of design showed that lightweight physical activities interweaved with employees' ongoing routines would be the best way to motivate them. Importantly, the design of QUTgo also takes into account by utilising the physical infrastructure of the university environment and providing a localised experience by encouraging employees to take longer routes in a familiar place.

### 4.2 More than step-counts: Enable social engagement

It is well-discussed in the literature [10,11,22] that activity tracking devices are not aimed at solving any problems, because being fit and healthy is not a problem to begin with. Rather, they are mostly used to provide an overall picture of individuals' lifestyles with respect to their physical activities, which can be seen as a motivator for them to change their lifestyles. That is not to say that activity tracking is used only for that purpose. There are domains where activity tracking devices are used to collect important health-related data to run medical diagnostics. However, we believe that a workplace is not an ideal arena where activity tracking devices can be used as diagnostic devices.

In all the three phases of our design, we found that 'step count' was a negotiated quantity and was not seen as an definite measure of physical activities. In the first phase, we saw that the prescribed benchmark of 10,000 steps per day was not a strict goal and some teams used their own internal benchmarks. At the same time, some participants compared their step-counting performance with that of their team members', rather than adhering to the prescribed step-count. There were instances where our participants compared their step counts with their peers and realised that even though the recommendation was 10,000 steps, they

can be reasonably active within the workplace with a slightly lower number of steps. In the second phase, participants mentioned that walking up and down stairs requires more physical effort compared to walking around the campus, and that step counting does not take such details into account. Similarly, in the third design phase, we saw that one participant walked around the campus to gain more steps rather than completing the challenge straight away. All this evidence suggests that simply attaining a specific step count or having a global target (e.g., 10,000 steps per day as prescribed by many health and wellness programs) may not serve well in supporting physical activities in workplaces. This is mainly because individuals have different preferences and needs with regards to physical activities, and one arbitrary exercise standard for everyone may not be appropriate.

QUTgo incorporates step-count as its main feature. However, its gamified features were what engaged our participants more. The interest they showed towards the news feed, and their reactions to seeing their colleagues outperforming them in terms of step counts have motivated them to take up more challenges. They would even take advantage of the "extra steps" by taking a slightly longer route to the challenged destination to accumulate higher scores. The fact that some participants used the application to set up meetings showed how the application enabled social engagement while keeping the essence of activity tracking intact. That is, instead of sending meaningless challenges to others, they have sent challenges which can be incorporated into their daily routines such as meeting for lunch or taking a coffee break.

These findings suggested that our participants have found ways to engage with the application and compete with their team members without hindering their day to day office tasks. We also believe that while step counting is what initially motivated the use of the application, the social elements are what drove the continuous use of it. The apparent curiosity among the non-users of the application also illustrated the power of the social elements as they have seen the users of the application engage in discussions around fitness as well as their ranking in the leaderboard. In that sense, we believe that the intervention which started off as a field trial aiming to identify how step counts can be used to engage users to be more active within the workplace has transformed itself as a means of promoting a healthier lifestyle.

### 4.3 Limitations

The work presented in this paper has been centred around a specific type of workplace – a university that has a specific type of people working for it, in a setting spread across a set of buildings. We realise that not all work environments are structured this way. An inherent feature in the resulting application prototype QUTgo is the use of the geofence feature that enabled registering people moving in and out of different buildings in the campus. Such a feature will not work if a work environment is spread across different floors in a multi-storey building. Hence, this work needs to be seen as a specific contribution to a geographically spread workplace. We believe that it would be possible to explore and design different types of interaction when a work environment is spread vertically.

Another limitation of this work is the longitudinal insights needed to assess the suitability of the prototype QUTgo. While we endeavoured to conduct a long-term engagement with the topic of activity tracking over three design phases, we consider that the work presented here is part of a 'design research' study where the aim is to learn how to design an activity tracking system. Our future work will focus on running a longitudinal study on the use of QUTgo. We also realised that it was not possible to conduct all

the three studies with the same set of participants, as certain work-related constraints did not allow us to recruit the same participants across the three studies.

## 5 CONCLUSIONS

Our three-phase design process has allowed us to develop a grounded understanding of the perceptions and experiences of employees towards physical activities and the role of an activity tracking system in a workplace setting. Our findings suggest that while step counting may be seen as an appropriate mechanism to motivate employees to increase their physical activities in workplaces, the mechanism has to be meaningfully interwoven into the existing routines and practices of employees. Our study shows that it is not about the step-count, but engagement around it matter more to the users. We also contend that social elements are important in supporting long-term engagement with activity tracking application. While our field trial of the resulting prototype application QUTgo was meant as a 'probe' than a final application, the insights regarding social elements that came out of it can be further refined to develop innovative applications.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