Design process and design evaluation of web-based visualization dashboard to monitor and support the decision-making of travel-related physical activity

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ABSTRACT

Patients suffering from coronary heart disease (CHD) require to attend cardiac rehabilitation to manage modifiable risk factors including physical activity (PA) to avoid the progression of the disease. However, attendance in these programs is low. Travel-related PA (TPA) monitoring via a smartphone app can provide an opportunity to assess the part of routine PA level. A digital framework consisting of a smartphone app to monitor travel behaviour and a semi-automated feedback report to show the performance of TPA was used in a pilot trial. An important component of this digital framework is a web-based visualization dashboard designed for healthcare providers to get insights into the routine TPA performance of their patients. This study aims to describe the design process and design evaluation of healthcare providers for the visualization dashboard. After designing the user interface screens of the dashboard, the prospective healthcare providers were contacted from the four hospitals in Belgium. Seven interested representative participants attended a focus group session. The session's proceedings were recorded and transcribed. A directed content analysis was used which utilizes a predetermined coding scheme. The usability of the web-based visualization dashboard's content (monitoring and enhancing TPA) was evaluated as of significant importance within and after the rehabilitation programs in the secondary prevention of CHD. TPA monitoring can be effective in motivating targeted patients who have sedentary lifestyles and do not attend rehabilitation programs. Experts particularly recommended adopting engagement strategies for the TPA monitoring and enhancing frameworks. The strategies to enhance patient engagement should be given high importance in future intervention design.

PETRA '22, June 29–July 01, 2022, Corfu, Greece

ACM ISBN 978-1-4503-9631-8/22/06…$15.00
https://doi.org/10.1145/3529190.3529207

CCS CONCEPTS

• **Applied computing** → Life and medical sciences; Health care information systems; Life and medical sciences; Consumer health; • **Human-centered computing** → Visualization; Visualization design and evaluation methods.

KEYWORDS

Travel-related physical activity, Visualization dashboard, Qualitative evaluation, Web-based dashboard design, Focus group

ACM Reference Format:
Tooba, Batool*, Yves, Vanrompay, An, Neven, Martijn, Scherrenberg, Veerle, Ross, Paul, Dendale, and Davy, Janssens. 2022. Design process and design evaluation of web-based visualization dashboard to monitor and support

the decision-making of travel-related physical activity. In *The15th International Conference on PErvasive Technologies Related to Assistive Environments (PETRA '22), June 29–July 01, 2022, Corfu, Greece.* ACM, New York, NY, USA, 8 pages. https://doi.org/10.1145/3529190.3529207

1 INTRODUCTION

Each year, 70% of the mortality is attributable to cardiovascular diseases (CVDs, e.g., coronary heart disease (CHD), heart stroke, and congenital heart disease) among other non-communicable diseases such as cancer, chronic respiratory disease, diabetes, etc.[24, 38]. It is reported that 80% of premature mortality of CHD can be prevented by managing its modifiable risk factors [11, 37]. Among these risk factors include physical inactivity, smoking, blood pressure, body weight, diet, diabetes, etc. [10, 12]. Physical inactivity is considered the precursor of various chronic diseases and contributes to higher risks of getting CVDs [35]. The guidelines for Physical Activity (PA) to avoid the risk of developing or further progression of the CVDs (both in primary and secondary prevention) include 150-300 minutes of moderate level PA or 75-150 minutes of vigorous level of PA or an equivalent combination of moderate and vigorous PA [11, 28]. Patients with established CVDs conditions are usually recommended to attend Cardiac Rehabilitation (CR) programs as an essential part of secondary prevention. These CR programs are specifically designed to reduce the progression of cardiac illnesses by limiting their physiologic and psychological effects [19, 27]. Besides the well-established clinical benefits of CR programs, the utilization of such programs is limited [31]. For example, only up to 30% of eligible patients participate in CR programs [7, 31]. Whereas CR programs facilitate exercise-based sessions, the routine assessment of PA outside the supervised CR setting is not done in practice [16, 21]. Therefore, practitioners in the cardiology field are interested in ways to assess lifestyle PA as an alternative for CR, including travel-related PA (TPA) and leisure walking and cycling trips, etc. Travel behaviour monitoring via smartphones can provide such an opportunity. Such smartphone apps (e.g., Health for Travel Behaviour, HTB) can gather various dimensions of daily travel routine in time (when) and space (where), including the purpose of the movement, the transport modes used, and travel partner(s) [23].

Assessment of the TPA via a smartphone app and effort to enhance it through routine travel of CHD patients has received little attention in previous research. However, a study by the authors proposed a digital framework Cardiac Travel Advice Support System (CTASS) to monitor and enhance the TPA of CHD patients [5]. The travel behaviour was analyzed automatically to assess the existing amount of PA level and after assessing the contextual details of trips, the suggestions about the trips which had the potential to increase TPA were provided based on distance-based decision rules. The TPA can be enhanced by replacing short car trips with active transport modes (i.e., walking and cycling). Later, a pilot randomised controlled trial (RCT) using two essential components of CTASS was successfully implemented with CHD patients [4]: 1) travel behaviour monitoring smartphone app (HTB), 2) semi-automated report generator (a feedback report on TPA was generated which was embedded with a behaviour change theory). A third component, a web-based visualization dashboard to facilitate healthcare providers was also part of the framework design [5]. In general, the primary use of digital dashboards has been described in the literature to support management and decision-making by providing easy and meaningful information from the data [20, 32]. Digital health dashboards, designed for the health management of patients, integrate the information on targeted quality indicators that effectively and precisely display patients' risk information to inform decision-making regarding early intervention and to improve the overall quality of patient care [32].

A web-based visualization dashboard was proposed as an important component of the CTASS digital framework. The main function of this dashboard was to make healthcare providers aware of their patients' performance of TPA and to support decision-making regarding when to intervene to manage the patients' health. The aims of the current study are as follow:

- Describing the design process of the web-based visualization dashboard (e.g., the features and functions, design principles of graphics used)
- Describing results of preliminary design evaluation from the end-users (healthcare providers) of the web-based visualization dashboard.

2 METHODS

2.1 Study design and participants

At first, while designing the web-based interactive and informative visualization dashboard, three functions were taken into account: 1) to present the TPA as well as other parameters of travel behaviour of patients, 2) to calculate the customized impact of the proposed change in TPA, and 3) to facilitate interventions from healthcare providers to send a personalized report at right time. The functions of the dashboard are designed to support healthcare providers in the cardiology field taking into account the very limited time that is available for them to counsel for TPA. In order to achieve the described functions, various User Interface (UI) screens of a dashboard were carefully designed considering the design principles of graphics. The navigation arrangement of dashboard screens was presented in an MS PowerPoint presentation aiming to get a preliminary evaluation from its end-users. Second, a focus group approach was used aiming at a preliminary evaluation of the content, sufficiency, usability, and navigation of visualization dashboard content presenting the TPA performance to healthcare providers. The prospective end-users of the visualization dashboard were identified (cardiologists, physiotherapists, research management and other rehabilitation staff) from four collaborating hospitals in Flanders, Belgium (Jessa, Hasselt; ZOL, Genk; SFZ, Heusden Zolder, AZ Delta, Roeselare). An email containing the purpose of the research study along with the designed dashboard's UI screens attached to the email was sent to the end-users. A focus group session was conducted on 27/01/2021 which lasted for 66 minutes.

The total number of participants was seven, and the eighth member of the focus group discussion was the moderator (researcher). The majority of the participants were physiotherapists (6/8) from the rehabilitation centres of collaborating hospitals. The last participant was from the cardiac research management team. To keep the anonymity preserved of all participants, they are referred to as P1-P7, from four collaborating hospitals: H1-H4. P1-P3 joined from

H1, P4 joined from H2, P5 joined from H3, and P6 and P7 joined from H4.

2.2 Analysis

The focus group session proceedings were recorded after requesting permission from the participants for analysis purposes. In the first 15 minutes, the moderator of the focus group presented a brief description of the whole project of monitoring and enhancing the TPA and the design of the visualization dashboard. The presentation included mainly the features and functions and designed UI screens. Afterwards, the moderator asked the questions and moderated the discussion concerning the usability and design of the visualization dashboard. The questions were based on predetermined themes, allowing feedback on specific aspects of the dashboard that provides patients' TPA performance. The recorded conversations were then transcribed verbatim by the main researcher TB.

The focus group discussion transcripts were analysed using the content analysis approach. Qualitative content analysis is regarded as a flexible approach to analyzing textual data which ranges from impressionistic, natural, interpretative analyses to systematic, strict textual analyses [17]. Various types of content analysis exist in literature mainly depending on the coding process used in analyzing the text. In this study, the directed content analysis [17] was used, meaning a predetermined coding scheme prior to the data analysis stage was utilized. The predetermined coding scheme was based on the main themes that allowed us to evaluate the dashboard design and its content: usability of monitoring TPA performance for patients' wellbeing, usability for healthcare providers, sufficiency and importance of presented travel behaviour parameters, and clarity in the navigation of the screens presented. At first, two researchers (TB and YV) independently highlighted and classified the text into the predetermined coding scheme. The coding schemes were generated using QSR International's NVivo 12 software, release 2020. The coding led to two new main themes that were first discussed and finalized in a meeting with the two researchers (TB and YV). These two final themes incorporate the content of the four predetermined themes. However, the summary opinion of the predetermined coding scheme is additionally added for a record. The final themes were approved by the remaining co-authors.

3 RESULTS

The results section comprises two subsections. The first subsection is the design stage which contains the description of features and functions and the design principles used in the development of UI screens of the dashboard. The second subsection provides the preliminary evaluation of the dashboard from healthcare providers and subsequent content analysis results.

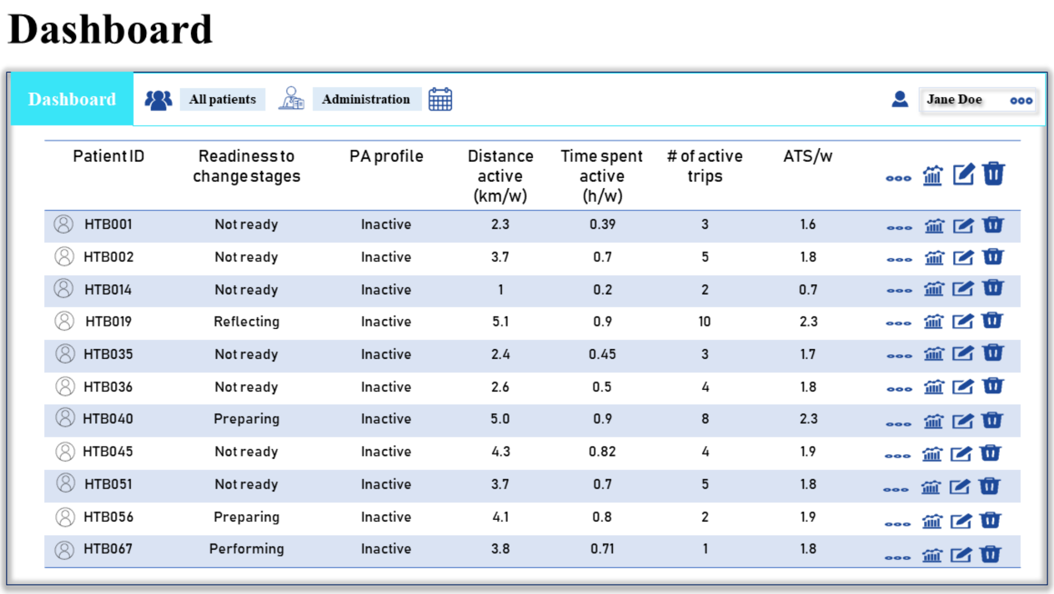
3.1 Design process

3.1.1 Informing the healthcare providers. The primary purpose of the dashboard is to inform the healthcare providers and it provides interactive graphic details of each patients' TPA performance. The key performance indicator (KPI), identified as Active Travel Score (ATS), is a measure of PA level which represents the multiplication of the frequency of walking and cycling trips and corresponding intensity in Metabolic equivalents (METs) [2]. ATS combines the frequency of walking and cycling trips and their PA (intensity) in METs which is extremely relevant for healthcare providers. Attaining ATS < 3 a week is categorized as inactive, 3-6 ATS as low active, 7-9 ATS as sufficiently active, 10-15 ATS as active, and >15 ATS as very active. The home screen of the dashboard presents the categories of the patients according to their risk profiles based on ATS. ATS is categorized in the risk profiles based on the standard recommended PA level of 150 minutes of moderate-intensity [28]. This means the time and intensity of walking and biking trips are converted into weekly ATS and it ranges from 7-15kcal/kg*week [6]. Presenting patients in these risk profiles on the first screen (home screen) provides quick access. This assists the healthcare providers to make decisions regarding corresponding risk profiles and actions required for the patients for instance at extreme risk, inactive patients who do not achieve the recommended daily PA level through outdoor travel activities. Apart from ATS, other dimensions of the patients' TPA performance (KPIs) relate to the number of walking, cycling, and car trips and the corresponding risk profiles. Clicking on the interactive tab named "inactive patients" leads to a second screen which provides the overview of the important KPIs (distance and time of active trips, number of active trips as well as corresponding ATS per week, and motivation stage) of each patient in the inactive group. The further details of the individual profile of a risk patient can be accessed using a button (Figure 1)

The individual report contains a list of all KPIs but the first opened screen will show the statistics related to the most important KPI, i.e., ATS as an interactive graphical weekly trend on the screen. Healthcare providers can also see the trends on a weekly or monthly basis, or on custom dates.
The complete list of KPIs includes:

- Number of active trips (walking and cycling), Number of car trips
- Distance active trips (for both walking and cycling trips), Distance car trips
- Time spent on active trips (for both walking and cycling trips), Time spent on car trips
- ATS active trips (calculated for both walking and cycling), Speed/intensity (on average for walking and cycling trips)
- Potential TPA
  - % of total replaceable trips by distance and modes
  - ATS if achieved by walk trips, cycle trips, and combined
- Calorie consumption active trips (for both walking and cycling trips)
- Type of activities/trip purposes
- Preferred partner (Preferred partner for both walking and cycling trips by activities

3.1.2 Calculating the impact of expected change. A feature to visualize the impact of an expected change can be useful to facilitate the healthcare providers' decision-making for recommending a specific change in the travel behaviour of their patients. This feature of the dashboard provides the estimation of the impact in terms of PA gain and change in the corresponding risk profile if a specific percentage of car trips is replaced with either walking or cycling. For instance, if a potential is identified from the majority of short distanced car trips, then the healthcare provider can suggest changing a specific



Patient ID	Readiness to change stages	PA profile	Distance active (km/w)	Time spent active (h/w)	# of active trips	ATS/w
HTB001	Not ready	Inactive	2.3	0.39	3	1.6
HTB002	Not ready	Inactive	3.7	0.7	5	1.8
HTB014	Not ready	Inactive	1	0.2	2	0.7
HTB019	Reflecting	Inactive	5.1	0.9	10	2.3
HTB035	Not ready	Inactive	2.4	0.45	3	1.7
HTB036	Not ready	Inactive	2.6	0.5	4	1.8
HTB040	Preparing	Inactive	5.0	0.9	8	2.3
HTB045	Not ready	Inactive	4.3	0.82	4	1.9
HTB051	Not ready	Inactive	3.7	0.7	5	1.8
HTB056	Preparing	Inactive	4.1	0.8	2	1.9
HTB067	Performing	Inactive	3.8	0.71	1	1.8

Figure 1: Dashboard screen displaying the overview of the important KPIs of each patient in the group

percentage from the predefined distance categories (e.g. 0-1.5km, 1.6-2km).

3.1.3 Sending the tailored reports to patients. The third important function of the visualization dashboard is to facilitate the required action, particularly for at-risk patients. The required action refers to generating and sending the tailored feedback report to the individuals or the whole risk group of patients. The patients can receive their feedback on an agreed interval between healthcare providers and patients attending CR or after completing the program. However, for patients with inactive and low active profiles, healthcare providers can send additional reports outside the usual schedule planned for all patients. The feedback report generation is facilitated in easy automated steps for healthcare providers. The tailored information of the patients is presented in the feedback report which is embedded with Transtheoretical Model (TTM) [4, 30]. In line with TTM, motivational stages (i.e., pre-contemplation, contemplation, preparation, action, and maintenance) can be matched with the sections of the feedback report based on related behaviour change techniques. The feedback report is comprised of different sections (A-G). All these sections are included by default in the report generation. However, every section tab on the screens also presents its significance for a particular motivational stage. The details of the feedback report content is provided elsewhere in other related publications [4, 6]. The healthcare providers either can include all sections of the feedback report (non-stage matched report) or only include stage-matched sections. In addition to the existing structured content of the report, healthcare providers can choose to add their personalized expert advice for the patients' encouragement or reinforcement.

3.2 Design principles

While designing the dashboard to inform the TPA performance of CHD patients to their healthcare providers, two design principles were kept in mind. The details behind selecting these principles and their use in displaying the relevant indicators are described in the following sections.

3.2.1 Overview first, zoom and filter then details on demand. In the design process of the prototype dashboard, the tips proposed by Ben Shneiderman in designing an advanced graphical UI were considered [33]. Following the argument that information is potentially better understood by applying to the visual domain, in comparison to other senses (e.g. textual reports, etc.), Shneiderman has proposed a basic principle in visual design as *"Visual Information Seeking Mantra: overview first, zoom and filter then details on demand"* [20, 33]. He proposed seven tasks as part of task taxonomy which also refers to the actions that a user would wish to perform: overview, zoom, filter, details on demand, relate, history, and extract [33]. We have utilized the relevant tasks suitable to our dashboard's objectives. For example, while opening the specific group of risk patients from the main screen, it provides an overview of the important KPIs for each patient in the list of which further details are accessed by clicking the profile of a particular patient (Figure 1). Moreover, the list of KPIs can be further zoomed out for adjoining details. Zoom, filter, details on demand and relate are used to manage the further details, highlight important KPIs and provide control over the specific time intervals required by healthcare providers. The number of steps in the information exploration on the dashboard screens is only 2-3 folds. The extraction principle was utilized in query parameters where the impact of the replaceable percentage of short trips is calculated and its addition

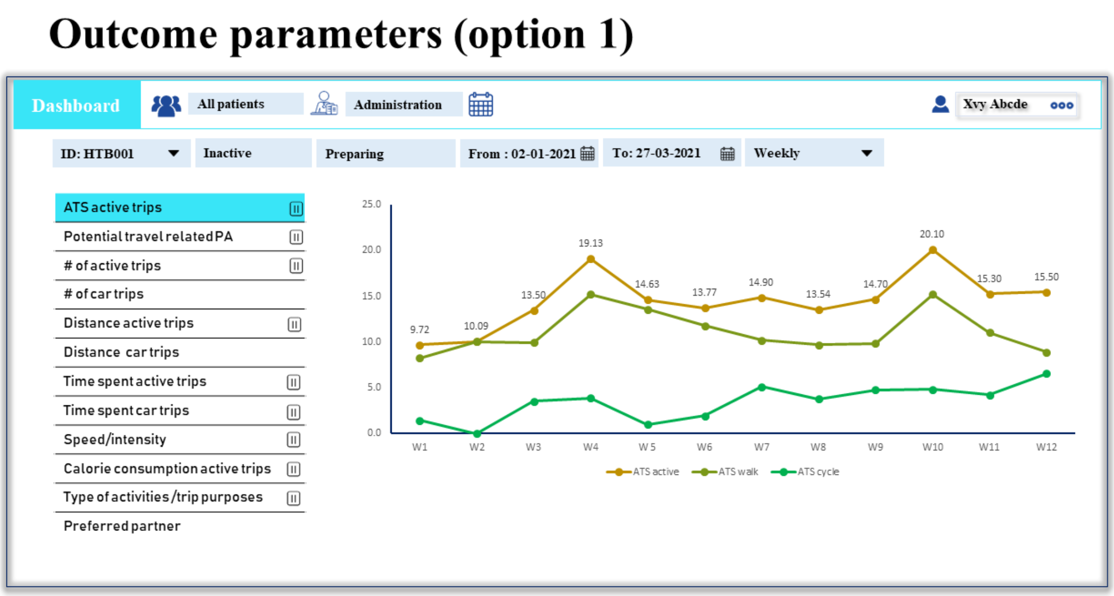


Figure 2: Dashboard screen displaying the interactive graph of ATS presenting weekly TPA performance of patient

to the feedback report of patients is also facilitated on the same screen. The advice can also be printed along with the individual report.

3.2.2 Minimizing the non-data ink and erasing the redundant data-ink. We aligned our graphical UI designs agreeing with Tufte's 1983 principles of data-ink ratio that, 1) minimising the non-data ink and 2) minimising the data-ink (reducing redundant data-ink). However, we also considered Stephan Few's point of view in highlighting the minimum redundant information that shouts out the important information for the convenience of the end-user [9, 13]. While displaying the quantitative data in the form of graphical displays or graphical trends, the unnecessary information providing no meaning was eliminated to reduce the distraction. Additionally, the main objective of the graph was emphasized more than the other information. For example, in the graph displaying the ATS, the values are indicated for combined weekly trends while these are not mentioned for the separated walking and cycling trends (Figure 2).

3.3 Qualitative evaluation of focus group session

Two main themes highlight the central ideas regarding the significance of the dashboard usability and its content from the discussion with the experts, which are described in the following subsections.

3.3.1 Monitoring travel-related physical activity as a "standalone framework" or an "integrated solution". The most discussed point in the focus group session with experts was the usability of monitoring and enhancing the TPA of patients. Almost all experts agreed on the positive significance of monitoring the TPA for CHD patients' well-being in secondary prevention. The majority of the experts considered the TPA monitoring and enhancing framework as a **stand-alone framework** that can be useful for the patients during as well as after the rehabilitation programs. However, the experts from H1 and H4 also discussed the benefits of monitoring the TPA performance of patients during rehabilitation as well.

> *"Perhaps it is not necessary to wait until after the rehabilitation. We also have the patients who come and train and we motivate them . . . they arrive with a car and when they go to home, they don't do it (PA) not anymore. When the rehabilitation ends then they still don't do a lot either. . . . so if you start the tool from the start, it might be complimentary perhaps." (P6.H4)*

The expert from H3 upholds the idea of monitoring TPA performance of particularly sedentary patients after the rehabilitation program as a home-based program. However, the expert laid out the reasons for this as: TPA is a source of lower intensity PA and thus the target should be the sedentary population who does not take part in the rehabilitation program, a higher intensity PA program, in order to at least start somewhere from a lower intensity. That also implied that the patients attending the rehabilitation programs are already motivated.

> *"I think that tool is very good for those people who are more sedentary and then they can get started by walking and those exercises . . . people who are also trained with physio-therapists and gaining a lot of experience and better condition, I don't think that's the problem" (P5.H3)*

The experts' opinions varied regarding the target population for enhancing TPA programs. Whereas, the participant from one

Table 1: Description of the pre-determined themes targeted in the focus group

Theme	Summary of opinions
Usability in terms of patient's well being	Monitoring and enhancing TPA tools was considered significant for all patients' health benefits in secondary prevention and in particular, the sedentary patients can be motivated even more to start with routine travel activities which have low intensity.
Usability of the TPA based dashboard	Communicating the TPA performance of patients to healthcare experts during the rehabilitation is as important as when after the rehabilitation program is completed.
Addition of other risk factors in the system	As a standalone framework to present the TPA performance of patients, the system does not require additional information on other risk factors. Healthcare experts are aware of these risk factor values through their EMR and face-to-face interactions
Navigation of the dashboard	Navigation through the various screens of the visualization dashboard was the least discussed topic during the session. The main barrier might be visualizing the PowerPoint screens into an actual virtual environment.

hospital proposed the target population for enhancing TPA as sedentary patients. Other participants from the remaining hospitals also endorsed targeting all patients to see their activities outside the rehabilitation center.

In addition, as a standalone framework to monitor and enhance TPA, it does not require adding additional measurements of other risk factors of CHD. The reasons for not adding them are that it can unnecessarily complicate the app functionalities, put an extra burden of manual input on patients and deviate the attention from the main outcome to achieve TPA.

> *"Because in those cases (i.e., adding risk factors) you can frighten your patients, what is blood pressure. Well at that moment it is just a number. You can not interfere (change) with those data when patients are seeing these values . . ., well it might not be dangerous but it is also not useful for the patients". (P2.H1)*

3.3.2 Patient engagement. In order to get a better performance overview of TPA, the healthcare experts' concern was the proper patient engagement in the process. The experts from two hospitals thought that feedback after three weeks was not enough and that it might lead to low participation and dropouts. The feedback should be provided more often and on regular basis, e.g., every week. Additionally, the integration within the smartphone app can be more persuasive. Another suggestion was to make the monitoring tool (i.e. HTB) as automated as possible so that patients do not need to put much effort to keep engaged with HTB.

> *"Because we see that in a lot of monitoring studies that after one month the patients' engagement is dropped a lot and you lose a lot of patients. And more you ask from the patients to manually do something, less engaged they will or for the shortest time they will be kept engaged." (P4.H2)*

> *"There are two types of feedback, you can have automated feedback directly coming from the app and then you can have the feedback that is provided by the rehabilitationers or experts which is more personalized of course". (P4.H2)*

The complete set of KPIs can be kept in the dashboard tool as an additional record associated with the main KPI (ATS) but the experts from the H1 showed the concern for patients that the feedback might become too much and complex if all KPIs would be shown in the feedback report. However, it was clarified to the experts in the focus group session that the feedback report was designed focusing on the main KPI (i.e., ATS)

> *"That is of course a lot of data that you can see, if you ask the patients it will take days for them to go over all this data." (P1.H2)*

4 DISCUSSION

Two main conclusions are drawn from the discussion with experts. Firstly, TPA is a necessary part of PA in patients' daily routine, although it should not replace the exercise-based CR programs. This conclusion is drawn from the fact that experts were interested in the lifestyle PA outside the CR sessions as well as after the completion of programs. In general, the patients attending the CR programs are usually more motivated to be active in daily life [1, 18] perhaps due to the PA counselling in CR programs [26]. Additionally, endurance and resistance exercises are as important as the lifestyle of moderate-intensity PA to improve the functional capacity and muscles strengths of the patients [26]. Secondly, it can be used to specifically target the patients who are sedentary and do not join rehabilitation programs. Age is one of the important barriers to attending CR or the reason for dropout. The risk of non-attendance or dropout increases with young age and current active employment and other utility activities lead to a lack of time [31]. Apart from this, travel time and accessibility to the rehabilitation centres are also important reasons for non-attendance and dropping out [3, 31, 34]. The TPA monitoring can increase the motivation of these patients with the perspective that they can achieve part of the required PA during their routine travel activities. The monitoring of TPA via smartphones provides additional contextual information (the sequence of activities in the space and time, purposes of activities, travelling partner), which is proven as an additional source of motivation to enhance the TPA in a qualitative evaluation of the HTB smartphone app performed by patients themselves [4]. The focus group participants have identified the importance of monitoring TPA in the secondary prevention of cardiac patients. The experts from all four hospitals perceived the usability of the monitoring and enhancing TPA tool for the patients' well-being as important, during as well as after the rehabilitation program. Additionally, the integrated solution providing the overview of both outdoor and indoor activities of cardiac patients would be more efficient as patients will be using a single platform (e.g. smartphone) and healthcare providers get a complete overview. However, that does not exclude the usability of a standalone TPA monitoring and enhancing tool as it is the source of important information that healthcare providers require in the secondary prevention of cardiac patients, apart from discretionary indoor exercises. An interesting finding came up during the discussion with healthcare providers about their concern regarding the patients' engagement. In their past experiences with objective monitoring of PA for long-term programs, patients' dropout is an issue. The experts suggested ways to improve engagement by providing the TPA performance feedback on regular basis and more often. The effect of regular feedback and as well as real-time feedback is positive in the success of interventions to enhance PA [8, 14]. According to the experts' opinion, the patients' engagement can also be influenced by the minimum manual input by the patients on the smartphone. The HTB requires user manual input to add three parameters (correction of motorized transport modes, selection of trip purpose, and travelling partner) of the travel diary [4]. There are technological limitations to fully automating these parameters [15] in travel behaviour monitoring. However, many successful ICT based self-management systems also use user input. The mAdherence tools is a growing field and exploring barriers to maintaining engagement [36]. Effective strategies to engage (e.g., patient-provider communication, targeted motivational messages, gamification) should be considered in the future development of TPA-based interventions. A meta-analysis exploring interventions promoting PA showed that interventions utilizing behavioural change theories and targeting insufficient active patients are more effective for the population's health [36].

Evaluation of the navigation of the design screens was the least discussed topic during the focus group session. As expected, it would have been difficult for healthcare providers to get a full grasp of the interactive environment from the provided screens. To overcome this difficulty, it is recommended to further pursue Design Science Research (DSR) [25]. DSR is a problem-solving framework for information system developments. DSR framework includes six steps: problem defining, defining requirements and features for artifact, design, and development of artifact, demonstration, evaluation, and communication [22, 25]. The preliminary evaluation in the current study can be considered as the first three steps in DSR where the significance of the problem, requirement of features, and design of the artifact are accomplished. In the second stage, after the development of an artifact (i.e. dashboard or integrated CTASS), another round of evaluation as ex-post evaluation [29] is recommended.

5 CONCLUSION

The current study aims to provide a description of the design process and design evaluation of the web-based visualization dashboard proposed to inform the decision-making of healthcare providers in cardiology. They can visualize the TPA performance of their CHD patients and interact when it is required. Design principles such as reducing the non-data ink and redundant data-ink and the visual information seeking mantra: overview first, zoom and filter then details on demand were considered in designing UI screens of the visualization dashboard. Monitoring and enhancing TPA was evaluated as of significant importance within, as well as after, the rehabilitation programs in the secondary prevention of CVDs. TPA monitoring can be effective in motivating targeted patients who have sedentary lifestyles and do not attend rehabilitation programs due to a lack of time and daily lifestyle activities. A perspective of enhancing the PA levels during their routine travel might be effective in motivating sedentary patients. Experts also highlighted their concern regarding the patients' engagement aspect for the TPA monitoring and enhancing framework. Therefore, strategies to enhance patient engagement with an ICT-based TPA monitoring framework are highly recommended for future intervention design.

ACKNOWLEDGMENTS

The authors would like to acknowledge Dr Pieter Vandervoort and Christophe JP Smeets for facilitating this research at ZOL's cardiology department and the rehabilitation centers. I am thankful for the cooperation of the staff of the rehabilitation centers in all four cooperating hospitals (Jessa, Hasselt; ZOL, Genk; SFZ, Heusden Zolder, AZ Delta, Roeselare) for recognizing the importance of the research topic and participation and engagement in the focus group session.

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