Requirements Analysis Towards Future Design of an Innovative Distance Learning Device Intended for French Orthodontic Practitioners

Contribution of a Community of Practice Analysis

Aurélie Mailloux
Orthodontics
Reims Hospital
Reims, France
e-mail: aurelie.mailloux@univ-reims.fr

Jérôme Dinet
CNRS, INRIA, Loria
University of Lorraine
Nancy, France
e-mail: jerome.dinet@univ-lorraine.fr

Abstract-The COVID-19 crisis has changed behaviors and needs of orthodontic practitioners related to (i) cancellation of all the continuing education events, which led to the disappearance of formal and informal exchanges on the practice (ii) emergence of numerous videoconferences, but without prior identification of practitioners' needs. The problem of interaction within a continuing education online environment is paramount: promoting interaction between peers within the system is essential to (i) reduce the feeling of loneliness (ii) promote users' commitment. Most French orthodontic practitioners were already involved in a virtual active Community of Practice (CoP) with their own way of fostering identification, cohesion, and collaboration. The purpose of this user-centered research is to identify requirements for creating an innovative comprehensive distance continuing education environment that would meet expectations and needs in terms of interactions of most CoP members, according to their experience (novices to experts). After an extensive state-of-the-art, used to better understand the changes in training and education related to orthodontic domain, we conducted (a) a detailed examination of the discursive activities within a CoP (e.g., content, interactions, rhythm, objectives, etc.) (b) four focus group and (c) an online survey. The collected data confirmed that an innovative complete distance continuing education environment could meet many CoP members needs, such as: anonymous, scientifically validated content, extensive or limited discussion forums, clinical case sharing, videoconferences instant translation, ease of access and cost and time saving. From a theoretical point of view, this study highlighted the crucial role of the community of practice in producing requirements for creating a useful, usable, and acceptable digital education environment for orthodontic practitioners.

Keywords-elearning; community of practice; psycho-ergonomic study; innovative device; orthodontics; continuing education.

I. INTRODUCTION

The COVID-19 crisis has changed behaviors and needs of orthodontic practitioners towards continuing education. Among others, the replacement of face-to-face congresses by videoconferences had led to the disappearance of direct formal and informal exchanges between novices and/or experts of the Community of Practice (CoP): the videoconferences current format only allows one-to-one vertical interactions between participants and speakers. However, in the field of distance continuing education, it is necessary to support a form of "e-presence" between members because one of the major dropout factors is the loneliness felt within the education device. Indeed, attrition rate is lower when the user is supported by his/her peers and interacts with them regularly [7][8]. According to the state-of-the-art [9]–[12], several solutions are mentioned to promote interactions and commitments within an education distance device, such as distance tutoring, and e-portfolio. However, their results are heterogeneous, and their implementation complex.

This innovative continuing education environment is addressed to French orthodontic practitioners who are mostly already involved in an informal active virtual CoP, built on Facebook© in 2014. In 2022 February, this CoP were gathering almost half of the French orthodontic practitioners. The purpose of this user-centered research is to analyze requirements to promote interactions within an innovative learning system based on a dual approach (i) the analysis of the virtual CoP discursive activity (ii) the identification of the CoP members' needs by conducting focus group and an online survey.

The remainder of this paper is organized as follows. After a state-of-the-art (Section II), Section III describes the data gathered and methodology applied in three different studies to identify the CoP members interactions needs and attitudes according to their experience (novices to experts). This is followed by an overview of findings in Section IV, categorized by the discursive analysis, the CoP members interaction needs and the requirements. Section V summarizes the value of these findings and outlines elements of future research to be conducted on the subject.

II. STATE-OF-THE-ART

We conducted an extensive state-of-the-art to identify (i) the possible benefits of designing an innovative distance learning device in the orthodontic domain (ii) the current solutions to promote interactions within distance education.

A. *Contribution of an innovative device*

The COVID-19 crisis has changed behaviors and needs of orthodontic practitioners. The need to evolve the traditional format to remote access is now widely shared. The COVID epidemic has greatly accelerated this trend related to cancellation of all the continuing education events [15]–[17].

The state-of-the-art [11]-[18][30][31] demonstrated that many devices dedicated to the continuing education of dentists or orthodontists have been created over the past 20 years, particularly in Anglo-Saxon countries. These devices were a source of satisfaction for the participants and effective in terms of learning and acquisition of skills but they were mainly centered on one unique theme (e.g., recognition of oral pathologies) and were not focused on the orthodontic discipline [13][14]. However, an innovative complete distance continuing education environment could have many advantages, such as flexibility, lower costs, no office closing and accreditation by the French body of Continuing Professional Development (CPD) [21]–[25].

B. *Existing distance learning device*

According to the state-of-the-art [11]-[18], there was no complete distance learning environment adapted to the French orthodontic practitioners' needs. Only two complete websites dedicated to distance continuing education were intended for orthodontic practitioners: the World Federation of Orthodontists (WFO) and the *e-orthodontie.com* websites.

First, the WFO website, with online videoconferences access and its smartphone application (with notifications), is the most complete digital continuing education environment available to date, particularly concerning the diversified content, supports, and the scientific validity. Despite this, none of the interviewed practitioners were registered with WFO probably because this device was neither adapted (i) to their expectations and attitudes (ii) nor to their way of interacting with each other. Correlation between cultural and/or social dimensions with the use of a distance education device has already been highlighted in a previous study [18].

Secondly, the French *e-orthodontie.com* website has been created in 2007 without no prior user-centered research to evaluate practitioners' needs and expectations [19][20]. That could explain why this website was very little used by French orthodontic practitioners, as evidenced by the closed to zero activity of the forums section.

C. *The interactions within the devices*

According the state-of-the-art [29], the loss of peer-to-peer interactions was the major drawback of the current distance education experiences for participants. That is why interaction represents one of the main issue to be considered for the design process. Nevertheless, several solutions are mentioned in the literature to create a kind of "e-presence" within the distance device, such as (i) virtual small groups of practitioners sharing same centers of interest or geographical proximity [27] (ii) creation of a collaborative e-portfolio [11][12] or (iii) tutoring [9][10]. But interactions between novices and their teachers *via* an e-portfolio were often limited, because, among other factors, teachers considered the digital feedback as a waste of time [11]. Concerning the remote tutoring, it remained generally underused because users struggled to meet their "ideal" tutoring model [9][10].

There are difficulties to maintain mutual commitment and trust in an online environment, hence the importance of examining the interactions within a current active CoP for creating a useful, usable, and acceptable digital education environment for orthodontic practitioners. We considered that an innovative distance continuing education environment, supported by the CoP members (and vice versa), could promote users' commitment. We based our approach on the horizontal social learning theories [3]-[6].

D. *Contribution of a community of practice analysis for education device design*

Several research-actions involving the design of training devices, in particular digital ones, are based on the notions of professional community in the education fields [33][34]. Although CoPs (i.e., traditional and virtual) have been developed and studied extensively in the education fields, they were fewer and less structured in the health sector [35].

However, horizontal exchanges between peers represent an important source of cohesion and group identification within the CoP [1]–[6][21]. Besides, learning results from the interaction with other individuals and particularly with the peers [3][4].

III. DATA & METHODOLOGY

To produce design recommendations for creating a useful, usable, and acceptable digital education environment for orthodontic practitioners, three techniques have been used (Figure 1). We conducted (i) observation of interactions and discursive activities within a virtual CoP *"discutons entre spécialistes (let's discuss between specialists)"*. (ii) Four different focus groups of 4 to 6 CoP novices to identify their actual behaviors related to training and education, their needs, and expectations (iii) an online survey of 59 participants to collect data about attitudes and expectations towards education addressed to the CoP members. Figure 1 presents an overview of the methodology adopted and its objectives:
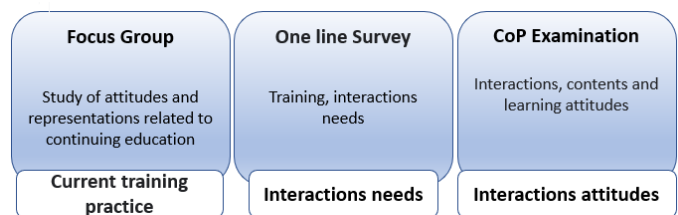

Focus Group	One line Survey	CoP Examination
Study of attitudes and representations related to continuing education	Training, interactions needs	Interactions, contents and learning attitudes
Current training practice	Interactions needs	Interactions attitudes

Figure 1. The triangulation of our methodology.

A. *Focus group*

Four focus groups bringing together 4 to 6 novices of the CoP novices were conducted: three focus groups were conducted before the health crisis and one after. The process was carried out in three stages:

(1) Identification of the difficulties, obstacles, and prospects of continuing education.

(2) Presentation of an existing French training system: the website *e-orthodontie.com*, to evaluate the participants' perception of digital training tools.

(3) Co-construction of "an ideal" website architecture dedicated to continuing education.

B. Questionnaire Survey

The online survey was conducted among practitioners, members of a virtual CoP. The electronic survey was prepared and distributed by the software Limesurvey© to all CoP members, first on January 11, then on January 25, 2022 (n=59 CoP members, including 41 CoP experts and 18 novices).

This online survey was conducted to identify:

(1) Reasons for which practitioners became members.

(2) what the CoP actually provided for its members.

(3) The members status: novices or experts.

In this study, CoP novices were defined as either orthodontic resident (i.e., already qualified in dental medicine) or practitioner with less than three years of clinical experience. CoP experts were defined as orthodontic practitioners with more than three years of clinical experience.

C. Examination of a virtual CoP

The dual purpose of this examination was (i) an identification of the current interactions and (ii) description of the discursive activity (in term of content, nature of exchanges, objectives, rhythms, comments and likes generated…) according to their experience (expert vs novice) within the CoP. This enables to study the discursive activity (e.g., rhythm, type of interactions, content within this CoP) and to identify the needs, attitudes, and expectations of the CoP members according to their experience (expert vs novice).

D. Data analysis

The focus group and the online survey data were analyzed as follows:

The textual analysis was carried out using free software IRAMUTEQ based on the R software and the Python language. After a manual thematic analysis, several automated analyzes were applied and in particular (i) the Reinert Descending Hierarchical Classification (DHC) model (ii) the Factorial Correspondences Analysis (FCA) and (iii) the similarity analysis. The DHC made it possible to divide the statements into classes marked by the contrast of their vocabulary. We completed DHC with a FCA which enabled us to observe the classes "geographical" proximity or distance. We also applied the similarity analysis when the number of segments was insufficient to obtain a saturation of the statements. We analyzed together the first three focus groups data (conducted before the health crisis), to compare them with the last focus group data (conducted after the health crisis). We also compared the online survey collected data between experts and novices (41 experts and 18

novices) to identify their common or divergent expectations and benefits of becoming member of a CoP.

The CoP interactions collected data were analyzed as follows:

All posts and interactions (in the form of comments or likes) of the month of September 2021 were subjected to a thematic content analysis to group them within categories /themes. The nature of the exchanges (e.g., copresence, cooperation, collaboration, identification), correlated with different contents and levels of interaction, have been studied in accordance with Proulx's taxonomy [36]. Interactions level was measured as the sum of comments and/or likes of each publication (low: < or= to 10; medium: > to 10 and < or = to 20; and high: >20).

We analyzed the comments (i.e., categories, feedback type and specific application) generated by clinical case posts basis on an evaluation grid of the "quality" of peer comments, produced in a previous study [32].

IV. MAIN RESULTS

Our findings indicates that (i) COVID-19 crisis modified the CoP members learning needs (ii) the interactions needs, attitudes, and expectations of CoP novices and experts were different.

A. Contribution of the virtual CoP discursive analysis

This innovative continuing education environment is addressed to French orthodontic practitioners who are mostly already involved in an informal virtual CoP, built on Facebook© in 2014. This virtual active CoP "*let's discuss between specialists*" (in French: discutons entre spécialistes) has significantly grown these last years. The growth of the informal virtual CoP these last three years (see Figure 2) seemed to be an underlying trend (i.e., +170% members since 2019). Indeed, the first COVID lockdown (i.e., start date 03/17/2020) did not seem to have modified this growth. In 2022 February, this CoP were gathering 1082 practitioners, representing almost half of the population (i.e., 2420 orthodontic specialists).
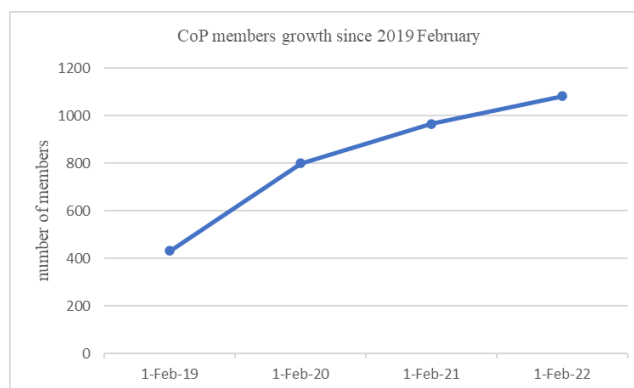

Figure 2. CoP growth since 2019.

The analysis of the publication's rhythm in September 2021 (n=59) revealed its cyclical aspect (see Figure3).
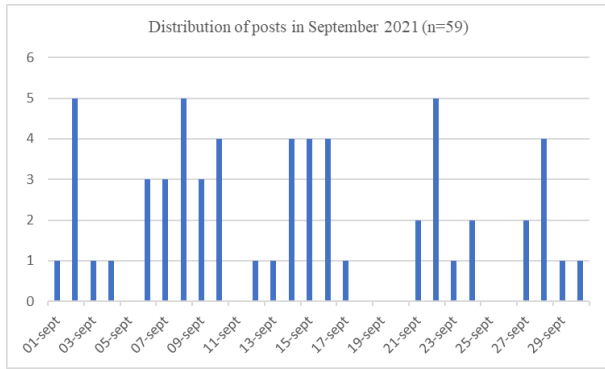
Figure 3. Distribution of the posts in September 2021.

The analysis of the authors' status showed that the start of a new cycle of publications coincided with a publication by a central CoP member (i.e., moderator, administrator, or recognized expert): their role was crucial in maintaining and developing the interaction.

Number of publications, interactions level and type after thematic classification (n=59 on september 2021)			
Thematic / *sub theme*	number	interaction level *(low, medium, high or inconstant)*	Interactions type *(none/comments and/or likes)*
Co-presence (n=24)			
job ads	3	low	likes
training information	8	low	likes
sale of practice	5	low	likes
patient communication	1	low	comments/likes
patient transfer	6	low	comments
link to other CoP	1	none	none
Cooperation (n=18)			
product/equipment advice	7	medium	comments
HR/legal advice	11	medium	comments
Collaboration (n=14)			
sharing of clinical cases	11	low or high	comments/likes
clinical tips	3	medium or high	comments/likes
Identification (n=3)			
ethical problem	1	medium	comments
criticism of private training	2	high	likes

Figure 4. Publications thematic analysis and the level of interactions generated.

Figure 4 shows the publications thematic analysis and the level of interactions generated. Most publications were of the order of co-presence among members, creating few reactions (mostly *likes)*. Their content was mainly informational. Publications on the mode of cooperation were less frequent but generated a higher level of interaction (mostly *comments*). The collaborative publications, generating a sustained interaction (i.e., clinical cases and clinical tips) were also rarer. During the month of September, three publications with strong identity value were published (i.e.,

one ethical problem and two criticisms of private training). These elicited many reactions (*likes* or *comments*).

However, all CoP members did not publish in all categories. The publications allowing either reflection on the orthodontics practice or collaboration among members, came exclusively from the CoP core experts, administrators, and moderators. The novices never participated in the form of posts or comments and very rarely in the form of likes. This observation agreed with the focus group collected data: all CoP novices (pre and post COVID-19 focus group) expressed their fear of being judged by the CoP experts. That was indeed the main barrier to their participation [5][37]. It is for this reason that anonymity was such a strong novices' expectation.

Themathic analysis of clinical posts (n=11 on september 2021)			
Thematic/*sub-theme*	number	interaction level	interactions type
Requested concerning a rare pathology	5	low	comments
=>including referring practitioners	2	low	comments
Sharing of successful clinical cases	4	high	comments/likes
Requested concerning complex diagnoses	2	high	comments/likes

Figure 5. Shared clinical cases detailed thematic analysis.

Figure 5 shows that practitioners never shared failures or treatments incidents, although this was an explicit strong request from novices, according to post COVID-19 focus group collected data.

Concerning the comments "quality" evaluation of the two "complex diagnoses" posts, they were rich in terms of content, supports (video, training, clinical case articles, etc.), feedback type (questions, suggestions, sharing of "imaginary" clinical cases, etc.) and reflections level (e.g., recommendations for good practices). But practitioners never shared personal clinical case to illustrate their comments, although it could enrich the discussion [32]. In this "clinical posts" category (unlike in the others), experts could sometimes contradict and criticize each other, revealing some disagreements. Nevertheless, the exchanges were much more subdued between novices and/or experts (and rarer). All publications related to illustrated clinical treatment (successful and complex diagnoses) generated feedback and initiated discussions, debates, and links to other problems.

According to the online survey collected data, the clinical publications were at the heart of the CoP (novices and experts) members' commitment (see Figure 5). In addition, discussions between peers about clinical cases could help novices to connect theoretical and practical knowledges [32].

B. Impact of the COVID-19 crisis on the CoP members learning needs

The comparison between the focus groups data collected before *versus* after the health crisis enabled us to describe finely the changes of continuing education perception, raised by the literature [15]–[17]. Regarding the interactions, in the pre COVID-19 focus group, the lack of informal exchanges between peers was a significant barrier to distance learning. The "ideal" learning experience was a

face-to-face conference, with limited costs and duration. In contrast, in the post COVID-19 focus group, the" ideal" learning experience consisted in clinical cases sharing (i.e., especially failed treatment) illustrated step by step, anonymous, internet-based literature search, scientifically validated content, and videoconference instant translation into French. The need to translate was strong for CoP novices, probably because they were afraid of misunderstandings without being able to detect them. The health crisis changed deeply the practitioners' perception toward distance learning. According to the literature, an innovative complete distance continuing education environment could henceforth meet many CoP members' needs [21][22][23].

C. Experts/novices : interactions attitudes, needs, and expectations

The distinct similarity analysis produced from novices and experts' responses to the online survey, allowed us to distinguish their expectations and needs towards the CoP (Figure 6). Figure 6 shows two different profiles in terms of content, interaction needs and attitudes within the virtual CoP "*let's discuss between specialists*". The experts expected to (i) be informed about the novelties, (ii) discover the practice and clinical tips of their peers. Their main goals were to evaluate their own practice and eventually modify them: that was a reflective learning process based on reciprocity. Concerning novices' needs, they expected to obtain expert opinions and were in an observant attitude.
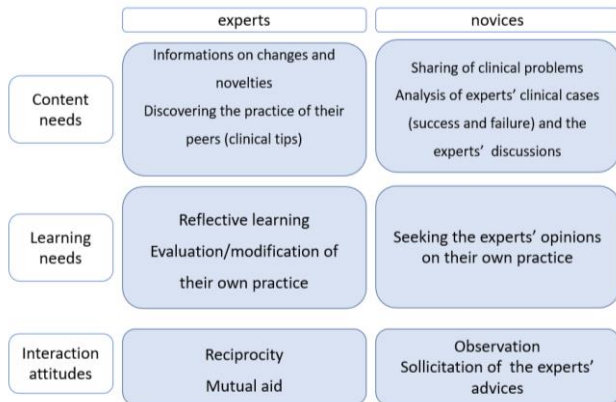

Figure 6. Experts and novices' needs in terms of content, learning and interaction.

D. Several requirements to promote peers interactions

The current virtual CoP supported via Facebook© did not allow to make small groups, nor to publish anonymously. An innovative continuing education environment should offer these possibilities to encourage novices' participation and ultimately stimulate interactions between peers. To promote practitioners' participation, according to the state-of-the-art and our collected data, some criteria should be respected:

First, participation in discussions forums could be done under a pseudonym. However, each practitioner's status should be known (novices/experts), so that novices could trust in the posted information.

Secondly, the content scientific validity could be ensured by various means:
-Review by known International/European clinical experts.
-Review by teachers from universities.
-Review by a mixed college (universities teachers and clinical experts).

Some of these experts should also ensure the discussion forums animation and take on the role of moderator to promote the interactions, as in the virtual CoP "*let's discuss between specialists*".

Thirdly, the device should allow the possibility of exchanging on his/her clinical cases via a forum, seeking the opinions of other practitioners or even having access to very detailed clinical cases (step by step).

Fourthly, the device should allow the creation of limited or extended discussions groups based on professional status (expert/novices). The geographical discussion group could also be relevant according to the CoP discursive analysis: 2 of the 11 clinical posts were indeed requests for referring practitioners in the same region (see Figure 5).

Finally, to improve the efficiency of the practitioners' comments in terms of learning and collaboration, a "quality" charter could be draw up, according to the peers' comments quality evaluation grid, to encourage them to: share illustrated personal clinical cases (successful and unsuccessful), ask for questions, make suggestions, share scientific articles, use a friendly tone, etc. [32].

V. DISCUSSION

The collected data (focus group, online survey, virtual CoP examination) agreed and complemented each other. This confirmed the interest of adopting a data triangulation method to formulate relevant recommendations [38].

Although learning within a CoP is a trajectory from novice to expert passing through intermediate stages. Despite this, the data analysis by dividing them into two groups (novices vs experts) allowed us to reveal different attitudes, needs and expectations in terms of continuing education.

It is commonly accepted that novices participated less than experts, because of their peripheral position within the CoP [3]-[6]. However, an education device should encourage all CoP members to participate on a voluntary basis, to reduce the feeling of loneliness and foster their commitment [4]. But, if virtual CoPs share the same principles than traditional ones (e.g., commitment and mutual trust), this is more difficult to maintain in an online environment [2].

Our collected data explained more precisely why the WFO and the *e-orthodontie.com* websites did not match users' expectations. Concerning the WFO website, there was a strong language barrier: in all focus group, the need to translate everything into French was commonly shared. Concerning the French *e-orthodontie.com* website, the content was perceived as not scientifically valid by interviewed practitioners. Moreover, this website was accessible to patients, specialist, and non-specialist

orthodontic practitioners. This "open access" was the subject of numerous criticisms by all the interviewed practitioners. All surveys revealed indeed the significant tension within this CoP related to the various academic backgrounds (specialists versus non-specialists). The open or limited access of non-specialists to the innovative distance learning environment should be carefully considered: the specialists considered the non-specialists as an outgroup of the CoP, whereas the non-specialist probably considered the specialists as experts of the CoP.

This paper showed that orthodontic practitioners commonly needed (i) scientifically validated content, (ii) discussion extensive or limited groups, (iii) anonymous, (iv) publications on clinical cases (successful AND unsuccessful). These results were consistent with the state-of-the-art. But contrary to the literature, in our study, the discussion forums group should be centered on the professional status (CoP novices and/or experts) and not on the center of interest [27].

It would have been interesting to carry out focus group of CoP experts but professional constraints (solitary practice, geographically scattered, lack of time) prevented us from doing so. Nevertheless, the online survey by questionnaire enabled us to include mostly CoP experts. The experts were numerous either because they participated more actively into the CoP, and/or because they were more represented there.

VI. Conclusion and Future Work

A complete, careful analysis of the orthodontic practitioners' needs, expectations, and interactions behavior within the virtual active CoP *"let's discuss between specialists"* was done for this innovative distance environment to comply with the criteria of usability and acceptability.

According to our data collection, a comprehensive distance learning environment could meet many novices and experts' expectations. Indeed, the CoP novices reported their need to (i) interact with experts anonymously (to avoid being judged) (ii) create restricted or extended online discussion (iii) ask for questions about all available content (e.g., videoconferences, articles) (iv) be informed of news by notification. The needs and attitudes of novices and experts we described in this study are supported by the data on the CoPs [1]-[6], particularly concerning cohesion, sharing of experiences and identity needs. However, the way to proceed is specific to each profession and, to our knowledge, no previous study has analyzed the orthodontic practitioners' community.

This study allowed us to identify the CoP members needs and expectations in terms of (i) content (and the categories structuring it), (ii) expected interactions between novices or experts (e.g., rhythm, themes, anonymity, etc), (iii) scientific validity, (iv) sharing or observing the peers' positives or negatives clinical experiences. On this basis, several requirements in term of interactions and contents have been proposed.

This users' center research showed that an innovative education environment would greatly enrich the CoP, particularly in terms of content, support, and variety of possible exchanges. All focus groups participants co-created a website architecture and discussed their expectations in terms of supports and contents to design an "ideal" distance learning device. The contents and supports will be the focus of a future article.

Our user-centered approach must be extended during the design/redesign phases by empirical methodology at different stages without and /or with "real" users, to ensure compliance with the device ergonomic criteria [39].

The security and legality of shared medical data such as X-rays and/or photographs of patients must be questioned. Further studies on the security aspects of the device are also important to be conducted to minimize the risks of malicious attacks and gain more confidence from the practitioners.

More extensive experimentation should be carried out, especially to deepen practitioners' expectations in post COVID-19 period to justify usefulness of the proposed requirements.

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