Navigational needs and requirements of hospital staff: Geneva University Hospitals case study

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***Abstract*— Navigating in large hospitals is a challenging task. The consequences of difficulties faced by staff, patients and visitors in finding their way in the hospital can be multiple. The HUGApp project goals are to identify the navigational needs and requirements of people within the premises of Geneva University Hospitals (HUG) before proceeding with potential solutions, such as an indoor navigation mobile app. A questionnaire was designed and distributed to staff members with the goal of understanding the current problems in wayfinding inside HUG, investigating the users' views on the creation of an indoor navigation mobile app, and specifying the user requirements for such an app. A total of 111 members of the primary care division of HUG answered the questionnaire, providing an insightful view of the healthcare professionals.**

***Index Terms*—Indoor positioning, Indoor navigation, Hospital way-finding, User requirements, User needs**

I. Introduction

Finding one's way in big complex buildings, such as hospitals, has been shown to be a rather challenging task. Finding the desired destination in a large hospital is identified as a difficult problem, not only for visitors/patients of a hospital, that may have no prior exposure to this environment, but even for the staff members of the hospital, that spend a great amount of their daily time in its premises. The fact that staff members can face way-finding difficulties can lead to cost and efficiency issues, putting aside potential cases of exposing patients' safety to risk. Also, if staff members face difficulties in wayfinding, it is normal that the difficulties will be greater for visitors, who will naturally stop and ask staff members for instructions. The fact that staff members are often stopped and asked for direction instructions can be often ineffective, as they might not know the answer or might be interrupted from important tasks they are supposed to be undertaking. Problems like this should be clearly identified, reported and understood before proceeding in finding appropriate solutions.

One of the domains that has gained great attention over the last decade is the utilization of indoor positioning and navigation mobile applications that help people navigate in large hospitals. The HUGApp project is a result of the joined interests of HUG (Geneva University Hospitals), and the University of Geneva, to report, understand and address the problems related to wayfinding difficulties in the premises of HUG. The HUGApp project aims to investigate the navigational needs in HUG and provide a proof of concept example of navigational aids implementation using ambulatory care as the initial setting. The final goal is to design a navigational aids solution for the totality of the HUG, that will be based upon users' needs and requirements. The project relies on a strong collaboration between the Division of Primary Care (Department of Community Medicine, Primary Care and Emergency Medicine, Geneva University Hospitals) and the Computer Science University Centre (Centre Universitaire d'Informatique) of the University of Geneva.

II. Related Work

One common problem that people face in their interaction with hospitals is the difficulty in finding their way, their destination, in the premises of the complex constructions that big hospitals are nowadays. Researchers have been focusing in addressing this challenge, offering a great volume of interesting work. In their remarkable work [1], authors from the University of Nottingham have discussed these issues in detail. The authors mention that: ... *Despite the provision of an array of in-hospital navigational aids, getting lost continues to be an everyday problem in these large complex environments.*[1] In that work, a series of semi-structured interviews with eleven participants was conducted to elicit information about a participant's navigation experience in a hospitals environment, characterizing five main categories of interest: (i) The Impact of poor navigation, (ii) Barriers to effective navigation, (iii) Enhancers for effective navigation, (iv) Types of Navigation Aids and user groups with (v) Specific Navigational Needs. Other works similarly discuss the problems of wayfinding in hospitals [2] or evaluate different kinds of assistance that facilitate hospital navigation [3]. In the latter work [3], 21 healthy volunteers were asked to navigate in publicly accessible parts of a large hospital, using three different kinds of assistance (i) written instructions, (ii) a map, and (iii) a video walk-

This work was co-funded by grants from the University of Geneva (Faculty of Medicine) and by the State Secretariat for Education, Research and Innovation of the Swiss federal government and the European Union, in the frame of the EU AAL project SmartHeat (aal-2014-153).
978-1-5090-6299-7/17/$31.00©2017 IEEE

through of the route. Completion times and observed errors were recorded for a route using the navigation aid and a return route without the navigation aid. The results showed that video users were over 30% faster than those using a map and over 40% faster than those given a written route description.

Older studies have even focused on more primitive aspects that can drastically affect a user's spatial perception, such as the floor numbering schemes [4]. The authors argue that the logic used to assign names in floor levels plays a crucial role in the users correct orientation and their spatial awareness.

Regarding indoor positioning systems in hospitals using a smartphone, there is a plethora of technologies used, such as Bluetooth [5], WiFi [6], RFID [7], and others. The idea of a mobile application that can assist people in finding their way in a hospital is a solution that could possibly become a commonplace during the next years. Indoor localisation systems are used, not only to assist people in finding their way, but also for more complex tasks like offering ambient assisted living to elderly [8] or feeding data to task management systems [6]. In a relevant work [9], the authors propose a Through-Life Management (TLM) approach, to ensure that wayfinding information remains immortal throughout the long life cycles of the building.

Works have studied the user acceptance of innovative mobile technologies that assist clinical staff of the hospital, not only in their wayfinding, but also in analyzing the tasks they undertake [10]. Some works [11], [12] have even proposed task simulations, similar to serious video games, to assist the training of junior doctors in non-technical skills during out-of-hours shifts, showing that participants in the intervention group completed their non-urgent tasks more rapidly than the control group.

Furthermore, great importance has been given to the creation of systems that respect the equal right of all citizens to access public services. Studies have been focusing on methods of appropriate assistance for the visually impaired [13], [14], [15], [16], or for people with other mobility limitations [17].

Questionnaires form a common method to report user needs and requirements, and are vastly used to identify user requirements regarding the use of location based services. For instance, recent works linked to the MULTI-POS [18] network have focused on personal safety concerns [19] or generally non-technical concerns [20]. At a broader context, travel patterns during pregnancy have been studied [21], by comparing trip duration given by Global Positioning System (GPS) tracking with the data obtained after asking pregnant women to give an estimation of their trip duration through a questionnaire.

Overall, it is clear that there exists a great interest in improving the experience of people in hospitals, by introducing innovative solutions, and most specifically, solutions of the rather recently popularized fields of indoor positioning and indoor navigation. The experience of wayfinding in hospitals is a vastly discussed issue, and working on understanding and improving this experience is a relevant and very interesting research task.

III. Current Status at HUG

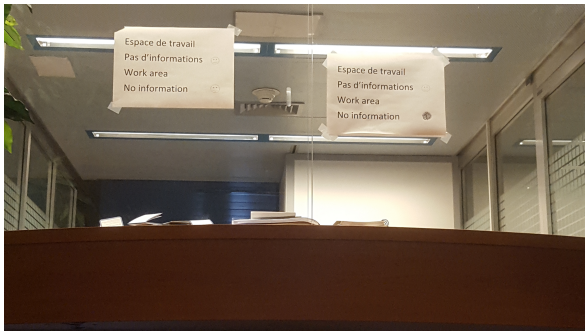
The existing navigational aids in HUG (Geneva University Hospitals) are following most basic standard practices used in hospitals internationally. Buildings follow consistent coloring and naming conventions (Figures 1a and 1d). Each building is assigned with its own color, and is named after a letter, while adjacent buildings are named with an alphabetic order. All elevators have detailed informative signs, highlighting the departments that can be found at each floor. Colored lines at the floor facilitate the way-finding of people towards main points of interest. Instructions like: *"...at the end of the blue line take the elevator to the second floor, and then follow the red line until the end."* can simplify the wayfinding for people. At central cross-points of each floor, a complete list of all existing rooms appears. A central reception at the main entrance of the hospital is staffed with people able to answer questions and give direction information. Similarly, the receptionists of each department can guide people, mainly within the area of the department.

Despite the fact that rooms are labeled properly and main directional information sources are available (detailed signs, building plans, colored lines at the floor, etc.), people keep facing difficulties in finding their way. The size and complexity of modern hospitals is such, that makes it impossible for users to find their way from any point A to any point B, only by following traditional signs. In addition, the language barrier can be a significant source of difficulties. All directional sings are written exclusively in French, which is the official language of Geneva. Switzerland has four official languages, and in addition, English is widely used as the official working language in many workspaces (International Organizations, multinational corporations, Universities, etc.) based in Geneva. The need of using the English language is revealed by an informal sign met at a very centrally placed office (Figure 1b), informing visitors that the office is a workspace and not an information booth. Lastly, a major need appears to be the disposal of tools that offer several language options, since HUG is responsible of taking care of vulnerable populations (refugees, asylum seekers), not speaking English nor French.

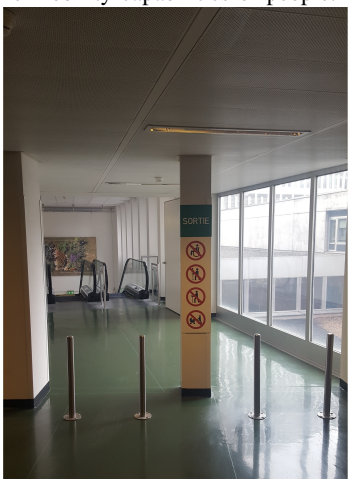
Signs, like the one in Figure 1a, guide people by taking into consideration their mobility limitations, highlighting the path that they should take according to their type of mobility. Nonetheless, in other occasions (as in Figure 1c), certain paths are highlighted as not suitable for certain groups of people (people using a cane, a wheelchair, or carrying a stroller), without providing though information for an alternative suitable path.

Another challenging task is keeping all relevant information updated, as the hospital environment changes. Renovations or rearrangements are often (Figure 1e). In those cases, simply placing the new labels to the new rooms at the end of the rearrangements is not enough, as other consequences should also be anticipated. The area where a renovation takes place can be part of a standard path (e.g, containing a colored line, leading at a destination) which turns inaccessible. Therefore,

(a) Each building is assigned with a different color and named after a letter. Instructions are given taking into consideration the mobility capabilities of people.



(b) A sign at an office located at a crossing of several corridors, saying *'Work area. No information'*. It was one of the few sings in the building written in both English and French.



(c) Warning sign before an escalator leading to the exit, mentioning that it is not suitable for people using a cane or a wheelchair. No alternative route sign exists though.

(d) Plan of buildings of the main campus of HUG. Naming and coloring conventions become evident to the user in this map.

(e) A corridor of the ground floor is being renovated. Access to the other end of the corridor is available only by going outdoors or through another floor.

Fig. 1: Photos related to navigational aids in HUG.

navigation aids should have the ability to dynamically adjust to the changing environment of a hospital.

IV. Motivation

The first goal of the HUGApp project is to identify the navigational needs of people in the Geneva University Hospitals (HUG). To do so, it is indispensable to register the current situation in HUG, to understand and evaluate the problems that people face when they try to find their way in the hospital. In general, often faced problems are: insufficient, confusing or outdated direction signaling, the language barrier, the lack of information material for people with reduced mobility, etc.

Apart from registering the current wayfinding problems, it was of great interest to identify their repercussions in people's life and work. The inability of a person to find their way in a hospital, may that person be a visitor, a patient, or a staff member, can affect their stress level, and particularly for staff, their productivity and cause their fatigue.

In addition to identifying the problems and their repercussions, a look towards the potential solutions should take place with a close collaboration with people that interact daily with the environment of the hospital. A study of the potential navigational aids that people are willing to use needs to be conducted before they are put into action. The technologies that could be used to improve the wayfinding in the hospital, along with the desired features of these technologies should be based upon user defined requirements. For these reasons, in this work the users were also asked to evaluate the importance of features that they would desire a potential navigation mobile application to have, as well as, the importance of services that could be built on top of such an app.

V. Methodology

A questionnaire was designed by a primary care physician and an indoor positioning specialist based on factors identified in the literature review. The questionnaire was created with the tools provided by GoogleForms. It was distributed by the email list of the division at the end of 2016 (November-December), to both physicians and non-physician healthcare providers as well as to staff of the administration. Out of

169 eligible collaborators, 111 (65.7%) answered the questionnaire. Among the collaborators that completed the survey, 61.3% were physicians (doctors), 56.7% of collaborators had $\geq$ 5 years of work at HUG, 70.2% were female, while the mean age was 39.6 years and the standard deviation 10.3 (Table I). A total of 70.1% were Swiss (persons with single and double nationality included, so nationalities were not mutually exclusive), while 84.7% were native French speakers. The vast majority of participants reported having a smartphone that supports Location Based Services (LBS)(87.7%), while most of them mentioned a high level of familiarity with smartphones and their applications (66.7%). All data were gathered anonymously and the questionnaires were completed in French.

TABLE I: Demographics of the subjects of the study that replied to the questionnaire (N=111).

Variable	Level	n	n/N(%)
Age	Mean	**39.6**	
	Median	**37**	
	Standard deviation	**10.3**	
Gender	Female	**78**	(70.2%)
	Male	**33**	(29.7%)
Nationality	Swiss	**79**	(71.1%)
	French	**27**	(24.3%)
	Other	**11**	(9.9%)
French language level	Native	**94**	(84.7%)
	Working proficiency	**16**	(14.4%)
	Sufficient for everyday needs	**1**	(0.9%)
Occupation	Doctor	**68**	(61.3%)
	Nurse	**8**	(7.2%)
	Administration	**25**	(22.5%)
	Other health-care providers	**10**	(9%)
Years of working in HUG	Less than 6 months	**5**	(4.5%)
	6-12 months	**1**	(9.9%)
	1-2 years	**9**	(8.1%)
	2-3 years	**9**	(8.1%)
	3-5 years	**14**	(12.6%)
	5-10 years	**24**	(21.6%)
	More than 10 years	**39**	(35.1%)
Possesses smartphone supporting LBS	Yes	**97**	(87.4%)
	No	**8**	(7.2%)
	Does not know	**6**	(5.4%)
Level of familiarity with smartphones	1 (Zero knowledge)	**3**	(2.7%)
	2	**12**	(10.8%)
	3	**22**	(19.8%)
	4	**62**	(55.9%)
	5 (Expert)	**12**	(10.8%)

VI. Results

In this section, the results of the questionnaires are presented and extensively discussed. Initially, a first list of questions helps depict a clear view of the current status of the navigational needs, the problems faced and their consequences, in the environment of HUG. Following, the user requirements are described, separated in three subsections: (1) technologies that users are willing to work with, (2) requirements of a potential mobile app that helps people locate themselves and find their way in HUG, and lastly (3) additional services that a mobile application could offer on top of providing location information.

A. Status report

In this section, questions regarding the current situation at the hospital are presented. Initially, the participants were asked if they had faced difficulties in finding their destination in the hospital (Figure 2). Only 9.9% of them answered "never", while 37.8% replied "rarely". The majority (52.3%) of the participants answered that they did actually face difficulties (36.9% occasionally; 14.4% often, 0.9% all the time). These results show that even for staff members of the hospital, not being able to find their destination at the premises of the hospital, that is their workspace, can be a recurring problem. It can be safely assumed that if people working in the hospital face these difficulties, the scale of the problem for visitors and patients will be even greater.

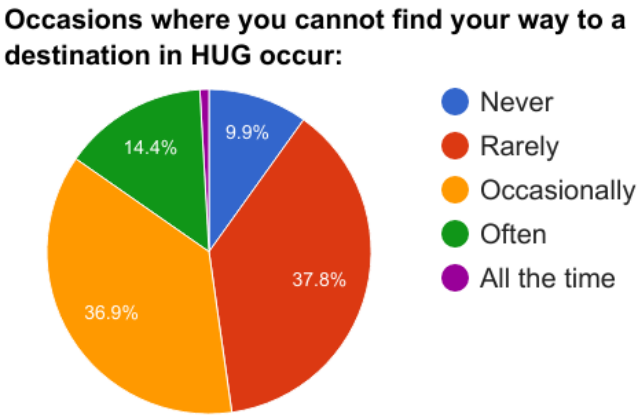


Fig. 2

In the following Figure 3, we observe that more than 50% of the participants reported that they have to give direction instructions with high frequency ("often" or "all the time"), with "often" being the most popular answer (48.6%). These results undoubtedly reveal a common and significant existing problem.

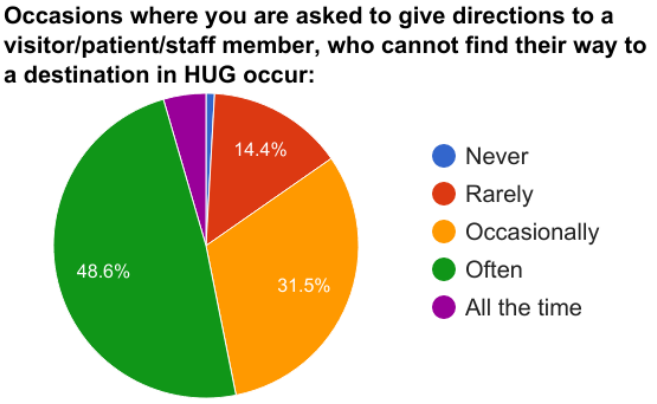


Fig. 3

Based on the answers of the previous question, the results of the following one do not come as a surprise. The majority of the participants (52.2%), characterize the existing indications that assist people in finding their way as insufficient (6.3% characterizing them as "very insufficient" and 45.9% simply "insufficient").

The participants were asked the following question: *"How many minutes per week do you estimate that you spend on searching for your destination in HUG or answering questions of others trying to reach their destinations?"*. The average value of the answers was 11.7 minutes and the median value was 5 minutes. Considering only the replies of doctors, the average value was 8.7 minutes and the median value was still 5 minutes, indicating that doctors are similarly occupied with answering wayfinding questions, as all other staff members. Moreover, a common problem is that staff members that are asked, are often not able to answer the question, so the question is repeated to other staff members.

The following two questions (Figure 4) intend to identify if the participants consider that the existing material that assist people in finding their way are well adapted for non-French speaking people, or for people with limited mobility. The results for the non-French speaking are impressive, as 18.9% of the participants characterized the signs to be "very badly" adjusted, and 53.2% said they are simply "badly" adjusted. It is noteworthy that there were no answers for the reply "very well", which was also available. The fact that almost three quarters of the participants report the inefficiency of the information in other languages, apart from French, is a significant observation, especially for such an international city as the city of Geneva.

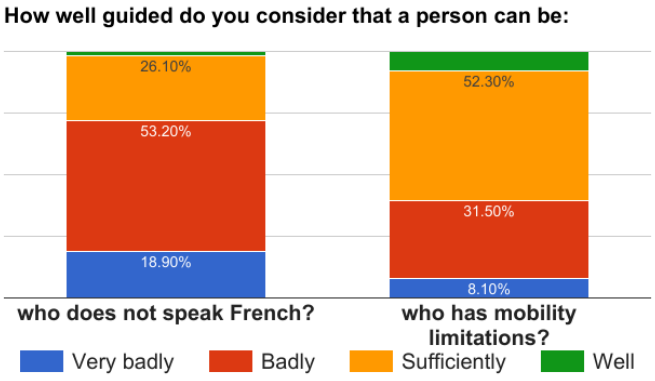


Fig. 4

For the same question, concerning people with mobility limitations, we observe that the most frequent answer is the middle option, characterizing the signs as "sufficient" (52.3%). Nevertheless, only 8.1% express a clearly positive evaluation ("well"), while a significant amount of people (39.6%) characterize them as "bad" (31.5%) or "very bad" (8.1%). Lastly, there were no answers for the reply "very well", which was also available. This result shows that there is space for improvement, especially as the environment at hand concerns a public hospital, were accessibility should be an equally shared right among all citizens, which is a constitutional principle of the Canton of Geneva. In the Canton's constitution, it is clearly stated that *"New buildings, accommodation places and work-spaces should be accessible and adaptable to the needs of people with disabilities. In the case of renovations, the needs of the latter are taken into consideration in an appropriate manner."* (Art.207.2, Constitution de la République et canton de Genève).

In the two next questions, the participants were asked if the difficulty of finding one's way in the hospital can be a source of stress, firstly for staff members of the hospital and secondly the visitors/patients. A total of 69.4% answered positively, concerning the staff members. Regarding the visitors/patients the results are truly impressive, as the difficulty in finding one's way in the hospital has almost unanimously (97.3%) been reported as a source of stress.

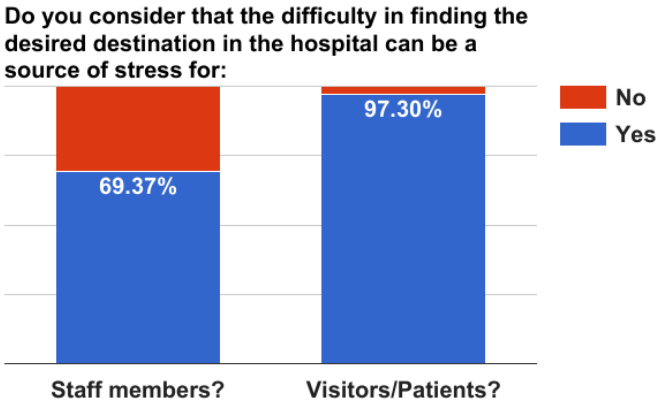


Fig. 5

B. User requirements

This section, consists of three subsections. In the first one, the views of the participants over future solutions are reported as well as their willingness to use mobile applications for navigation. Subsequently, requirements for a potential mobile app that helps people locate themselves and find their way in HUG are reported. Lastly, a list of additional services that a mobile application could provide on top of providing location information is evaluated.

1) Technologies: Before proceeding to the questions that are specific to a mobile application approach, it is important to ask the participants about the way they believe that wayfinding will be improved in the future. The participants could make multiple choices from a list of solutions, shown in Table II, while they were also given a free text option. Most mentioned that the signs should be improved (81 votes). The strategical addition of landmarks that would help differentiate similarly looking environments was the second most popular option with 59 votes, followed by the solution of interactive screens throughout the hospital that offer relevant content (maps, instructions, etc.), with 57 votes. Close to the two previous solutions comes the mobile application approach, with 54

votes. Improved colored lines on the floor, and volunteers helping people in wayfinding complete the list with 44 and 41 votes respectively. In addition, in the free text field, some interesting suggestions were given. One participant wrote: *"Editing of a colored document, personalized and handed out by hostesses (such as a Mappy or ViaMichelin or Google Map route) for people who are not used to new technologies."*. Another reasonable remark was underlining the need for: *"A 'natural' (intuitive) numbering of offices / meeting rooms / consulting offices"*. Lastly, there were suggestions indicating that, regardless of the improvements, there will always be the need for humans to accompany visitors, especially foreigners or elderly.

TABLE II: Amount of answers to the multiple choice question: "In which way do you think that way-finding in hospitals can be improved in the future?"

Solution	Number of votes
Improved signs	**81**
Strategically add landmarks, such as photos or paintings, to help people identify and differentiate similarly looking environments.	**59**
Interactive screens throughout the hospital, offering location information (such as maps, instructions, etc.).	**57**
Smart mobile applications offering location information (such as maps, instructions, etc.).	**54**
Improved colored lines on the floor.	**44**
Volunteers (potentially old staff members) who help people in way-finding.	**41**

The participants selected, in average, more that 3 options from the list, showing that there does not exist a single way that seems able to undoubtedly solve the wayfinding problem in hospitals. On the contrary, according to people's feeling, the combination of several improvements seem to be the way that the problem will be handled in the future.

Having identified the need for a multifarious approach in addressing the navigational needs of people in hospitals, we proceeded in asking the view of participants regarding the creation of a relevant mobile application. The participants expressed a very positive view over the prospect of the creation of an application for mobile phones that would guide people to their destination, in HUG. On a scale from 1 to 5 (1: negatively - 5: positively), the most frequent evaluation values were 4 and 5, corresponding to positive evaluation, with 36% and 29.7% respectively (Figure 6). Negative evaluations (1 or 2) come from a small percentage of participants (9%). The average score was 3.85. One of the participants that gave a negative evaluation, justified it by mentioning the increased concern about people spending more and more time in public places by being totally focused on the screen of their smartphone.

The participants were asked to evaluate how likely it is for them to use such an app, on a scale from 1 to 5 (1: certain not to use it - 5: certain to use it, as seen in Figure 7). The most frequent answer is 5 (certain to use it) with 29.7%. Only 12.6% gave the lowest value 1 (certain not to use it), among whom most do not have a smartphone supporting location services, ergo their certainty. The average score was 3.42. This positive acceptance of the prospect of such an app is significant considering that the questionnaire was directed to hospital staff that is supposed to be familiar with the hospitals environment.

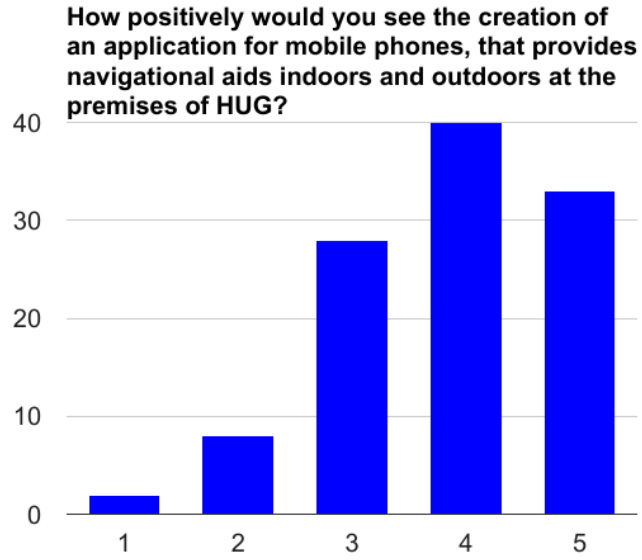


Fig. 6: Number of evaluations per evaluation score (1: negatively - 5: positively).

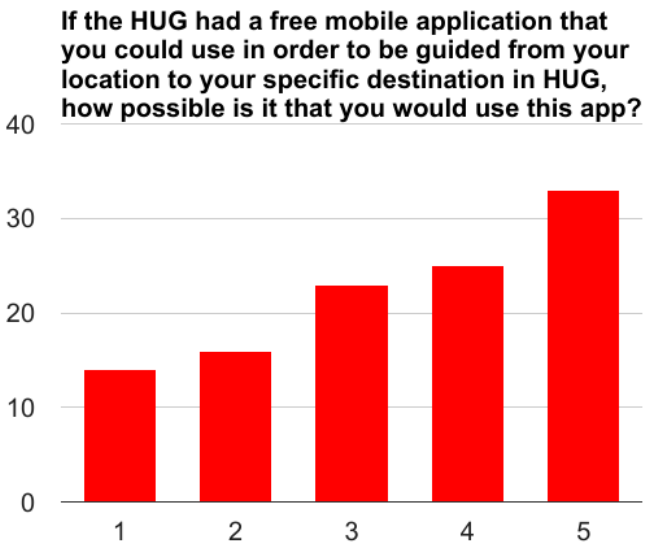


Fig. 7: Number of evaluations per evaluation score (1: certain not to use it - 5: certain to use it).

Combining the results of the last two questions with those of an earlier one regarding the time that the participants estimate that they spent in providing direction instructions, brings an interesting result. While the average time spent for all participants was 11.74 minutes per week, for those viewing positively (score: 4 or 5) the creation of a mobile application the average time is 15.01, while for those certain to use it (4 or 5) it is 15.92. These results show that staff members

that are mostly facing the problem of people getting lost in the hospital are those that emphasize the necessity of such a navigation aid. Lastly, a result that could be characterized as counter intuitive is the fact that the average age of those certain to use the app (4 or 5) is 40.7 years, in comparison with the 39.6 years of all participants. This shows that it is not only the younger staff members that are willing to use modern technology, as the average age is slightly increased for those eager to use it.

2) Mobile app requirements: The participants were asked to evaluate the importance of features (on a scale from 1 to 5, with 5 being the highest importance) that they would expect a navigation application to have. In Table III, we can see the average importance score that the participants gave to each of these features. In brackets, we see the relative ranking of the features in the list.

TABLE III: Average user evaluation (and ranking) of the desired features for a navigation mobile application, at a scale of 1 to 5, with 5 indicating high importance.

Feature	Importance (Rank)
Estimating my position accurately.	**4.45** (4)
Smooth flow of position estimates (no abrupt jumps of the position estimates).	**3.80** (10)
The trajectory towards my destination should appear in a map.	**4.52** (1)
Direction instructions should be given by arrows.	**3.96** (8)
Direction instructions should be given by explanatory text.	**3.37** (11)
Direction instructions should be given verbally.	**2.95** (12)
The application should be available in many languages.	**4.16** (6)
The application should be able to take into consideration the mobility capabilities of users.	**4.49** (2)
The application should not require internet connection in order to function correctly.	**4.27** (5)
The application should have low battery consumption.	**3.86** (9)
The application should protect my privacy.	**4.49** (3)
The application should combine its directions with the existing navigational aids of the hospital, as the colored lines on the floor.	**4.14** (7)

We observe that the most important feature is the one concerning having a map on which the estimated position appears. It is true that having an interaction with a map on which their position appears is much easier and more intuitive for the users than other approaches, like simple text instructions, etc. At the second place, we find the need of taking into account the mobility capabilities of the users. A navigation application that would not take into account the mobility of its users would be discriminatory and inappropriate, especially for the environment of a hospital. It is notable and quite positive that the professionals of healthcare prioritize needs that way. At the third place, and not much below the rest, we find the privacy protection, which is generally highly valued when dealing with medical information. At the forth place appears the feature concerning the high accuracy of the position estimates. Having a high accuracy in the indoor positioning system is a naturally expected requirement, since the correct functioning of the application relies on this accuracy.

The features that were ranked as the least desired are the following: having direction instructions given in written text or verbally, the smoothness of the sequence of position estimates, as well as the requirement of the low battery consumption. Instructions given written or verbally can be an additional, optional feature on top of the most important features of showing the user position in a map and providing direction instructions with arrows. Moreover, the low importance that the participants gave to the low battery consumption requirement could be interpreted in the sense that people who use smartphones are familiar with the fact that location services tend to require a fair share of the battery's energy. Nevertheless, handling a trade-off between low battery consumption and good performance should be the goal of every modern mobile application.

3) Additional services: Lastly, the participants were asked to evaluate the importance of a variety of potential additional services that a mobile application could offer on top of providing location information. In Table IV, we can see the average importance score that the participants gave to each of the potential services.

TABLE IV: Average user evaluation of potentinal additional services, at a scale of 1 to 5, with 5 indicating high importance.

Service	Importance (Rank)
The application should allow users to communicate through a messaging system.	**2.15** (5)
The application should allow users to share their location with others.	**2.27** (4)
The application should provide reminders to the users when the time of an appointment is approaching and advise them when to depart, taking into account their current location.	**3.4** (3)
The application should facilitate the hospital staff in organising meetings by providing information about the vicinity and availability of meeting rooms.	**3.4** (2)
The application should be able to inform and guide professionals to the room where a meeting that they are supposed to attend is taking place.	**3.78** (1)

By the scores given to these services, we can observe that, in general, the additional services are not characterized as important as the main desired features presented in Table III. The most desired service, that has an average importance score of 3.78 is the last one, which describes the application being able to inform and guide professionals to the room where a meeting that they are supposed to attend is taking place. An appointment reminder service and a service facilitating the organization of meetings and the booking of meeting rooms received the same importance score (3.4/5). Having a messaging system or the possibility to share the location with others could potentially be useful, as a patient could share his location with their doctor some time before the appointment, so that the doctor knows if the patient is arriving on time. These two options though were not characterized as important by the participants, with 2.15/5 and 2.27/5 respectively.

VII. Conclusions

The questionnaire offered a great insight concerning the identification of the navigational needs of people in HUG. The survey shows that both visitors and staff members are facing difficulties in finding their destination. This is identified as a source of stress for both groups. Also, a decent amount of the personnel's time is spent in assisting people finding their way. The fact that the existing material is inefficient for people that do not speak the official language (French) is clearly revealed. A similar impression is reported for the material assisting people with mobility restrictions.

The participants showed very positive feelings regarding the creation of a mobile application that can help people be guided in the hospital. Problems that were highlighted as frequent and important, such as not taking into account the users mobility limitations or their language preferences, are easily solved with a mobile application that can customize its function according to the user needs. Concerning the required features of the app, the results are very interesting. The ability to adjust the information according to the mobility restrictions of the users has been highlighted as a feature of very high priority. Also, people want an app that guarantees privacy protection. They expect a system that has a good accuracy in estimating the users' position, and that displays their position and the direction instructions on a map.

As future work, we plan to proceed in the creation of an indoor navigation mobile app using agile software development methodologies, keeping a close collaboration with all stakeholders, and most importantly the final users, included in the decision making as the project advances.

Acknowledgements

The authors would like to thank Cathrine Zarola, Abbass Hammoud, Alberto Olliaro and Kevin Salvi for their active help during the execution of this study.

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