Usability analysis of indoor map application in a shopping centre

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Abstract. Although indoor navigation is still new in Indonesia, its future development is very promising. Similar to the outdoor one, the indoor navigation technology provides several important functions to support route and landmark findings. Furthermore, there is also a need that indoor navigation can support the public safety especially during disaster evacuation process in a building. It is a common that the indoor navigation technologies are built as applications where users can access this technology using their smartphones, tablets, or personal computers. Therefore, a usability analysis is important to ensure the indoor navigation applications can be operated by users with highest functionality. Among several indoor map applications which were available in the market, this study chose to analyse indoor Google Maps due to its availability and popularity in Indonesia. The experiments to test indoor Google Maps was conducted in one of the biggest shopping centre building in Surabaya, Indonesia. The usability was measured by employing System Usability Scale (SUS) questionnaire. The result showed that the SUS score of indoor Google Maps was below the average score of other cellular applications to indicate the users still had high difficulty in operating and learning the features of indoor Google Maps.
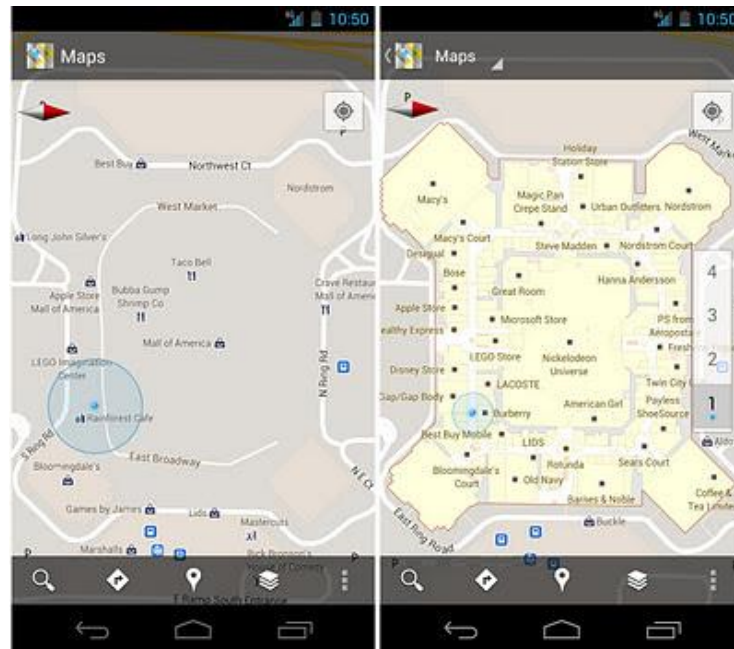
1. Introduction

A mobile navigation application (app) is a software which provides cellular users with various navigational functions and features [1]. Such an example, by using input from the users, some navigation apps are able to determine the optimum route to travel from users' position to another specific location in a geographic region [1]. The mobile app can be used for both outdoor and indoor navigations. An outdoor mobile navigation app is supported by the technology which combines cellular signals and Global Positioning System (GPS) signals for determining the location of a mobile phone user [2]. In case of indoor mobile navigation, since GPS signals cannot penetrate most solid objects such as buildings, mountains, and water [1][2], IPS (Indoor Positioning System) technologies are being developed by companies like Google, Microsoft and Nokia to offer pinpoint location accuracy even while users are inside a building [3]. IPS provides users with several indoor navigational functions. According to a research conducted by IndoorAtlas at 2016 [4] on 298 respondents, two most desirable functions of IPS were the navigation or finding the route (42%) and searching for points/locations of interest (31%). Twenty eight percent (28%) of the participants also mentioned that there was a need for a function of IPS which can help public security and anticipating a disaster [4]

In order to provide optimum benefits and functionalities for its users, an indoor mobile navigation app should have acceptable usability level. According to ISO 9241-11[5], usability is the extent to which a system, product, or service can be used by specific users to achieve specific goals with effectiveness, efficiency and satisfaction in a specified context of use. Furthermore, the usability level

of an app will influences the user performance in operating it. For indoor navigation applications, the performance indicators could be the speed and accuracy of searching the points of interest or guiding users to the desired destination.

Figure 1. Indoor Google Maps interface.

Given the benefits of indoor navigation apps and considering that they are recently introduced in Indonesia, a usability analysis of this type of applications for Indonesian population is needed. Among several indoor map applications which were available in the market, this study chose to analyse the usability indoor Google Maps due to its availability and popularity in Indonesia. Indoor Google Maps is an indoor navigation product embedded on the Google Maps app which was firstly introduced in Google Maps version 6.0 for Android [6]. In the app, the details of the floor plans will appear automatically when a user is viewing or enlarging the map of a building which is equipped by indoor map data (see Fig. 1). Furthermore, indoor Google Maps uses Wi-Fi technology to perform indoor positioning [7]. In Indonesia, the indoor Google Maps app is available in around 60 buildings across 13 cities in Indonesia, ranging from shopping centres, airports, museums and universities [8].

2. Methodology

2.1. Object of the study and participants
This study was conducted at Tunjungan Plaza Shopping Mall, one of the biggest shopping centres in Surabaya Indonesia. The shopping centre was selected due to its high spatial complexity which was suitable for testing the usability of indoor Google Maps. Twenty two participants (11 males and 11 females) aged between 20 to 22 years took part in this study. All the participants were regular users of android smartphones and based on the preliminary interview, all of them had limited knowledge on the layout or floor plans of Tunjungan Plaza Shopping Mall.

2.2. Experiment tasks and apparatus
Each of the participants was required to do four experiment tasks as follows:
- *Task #1*: open Google Maps app and find indoor Google Maps feature.
- *Task #2*: search a location of a clothing store, namely "Coach" in the indoor Google Maps and follow the route suggested to arrive at the clothing store.
- *Task #3*: find public facility signs/icons in the Tunjungan Plaza's indoor Google Maps.

- *Task #4*: Go back to your initial location before you conduct Task #2.

In conducting all the four experiment tasks, each participant used a same smartphone which was Asus Zenfone 5 A500CG. During the study, the smartphone was constantly connected to the internet.

2.3. Usability testing

After each of participants completed the 4 experiment tasks, he/she was required to fill in the System Usability Scalability (SUS) questionnaire to measure his/her perceived satisfaction on the indoor Google Maps which indicated the usability of the app. SUS was one of most popular standardized usability questionnaires [9][10]. Regarding Sauro and Lewis [10] the questionnaire was employed by 43% of recorded usability studies.

The SUS questionnaire consists of 10 items, half of them worded positively and the rest worded negatively, listed as follow [10]:

1.   I think that I would like to use this system frequently.
2.   I found the system unnecessarily complex.
3.   I thought the system was easy to use.
4.   I think that I would need the support of a technical person to be able to use this system.
5.   I found the various functions in this system were well integrated.
6.   I thought there was too much inconsistency in this system.
7.   I would imagine that most people would learn to use this system very quickly.
8.   I found the system very cumbersome to use.
9.   I felt very confident using the system.
10. I needed to learn a lot of things before I could get going with this system

A factor analysis conducted by Lewis and Sauro [11] on the ten items resulted on a two-factor solution. Item 1, 2, 3, 5, 6, 7, 8, and 9 were on one factor namely "usable" and items 4 and 10 on the other hand were grouped in one factor called "learnable" [10]. In this current study, the order of the items was presented randomly to each participant to minimize the sequence effect.

Each item of the SUS questionnaire was presented to the participants as 5-point scales numbered from 1 (anchored with "Strongly disagree") to 5 (anchored with "Strongly agree") [12] .If a participant fails to respond to an item, the centre of the rating scale (i.e., 3) was assigned on it [12] . On the next step, score contribution of each item was determined [12]. For positively-worded items (1, 3, 5, 7 and 9), the score contribution is the scale position minus 1, while for negatively-worded items (2, 4, 6, 8 and 10), it is 5 minus the scale position [12]. The overall SUS score was calculated by multiplying the sum of the item score contributions by 2.5, accordingly, SUS scores range from 0 to 100 in 2.5-point increments [12]
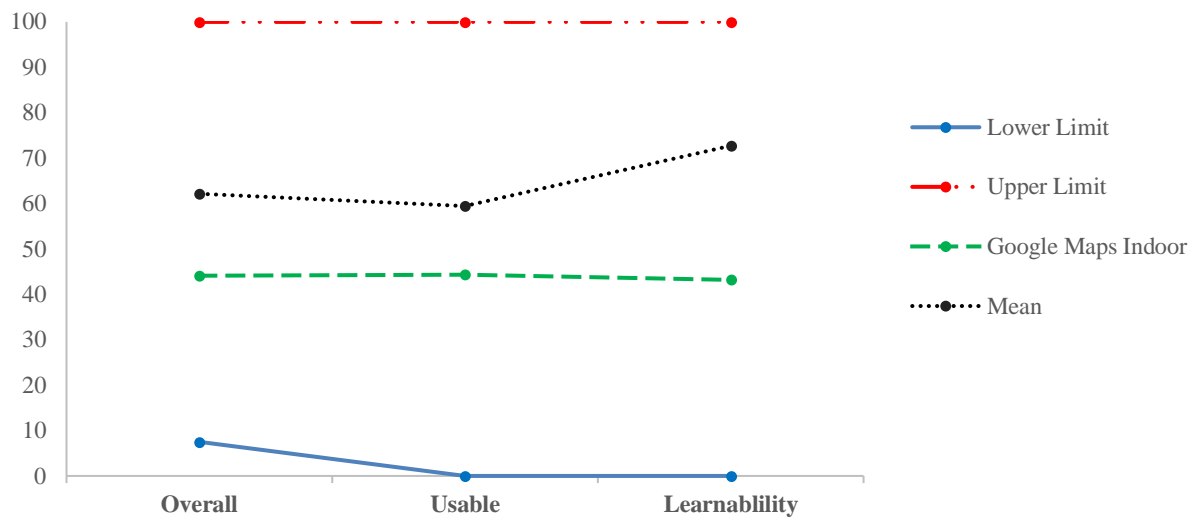
Previous researches such as Sauro and Lewis [10] and Bangor et al. [13] on the psychometric properties of the SUS provided norms [12] to justify whether a SUS score for a specific product is on acceptable level. A survey on 324 usability studies conducted by Sauro & Lewis [10] showed that the average of SUS scores is 62.1 for overall, 59.44 for usable scale and 72.72 for learnability scale. Regarding Bangor et al. [13], the SUS score below 50 is considered as unacceptable. Furthermore, Bangor et al. [14] developed a grading scale in which similar to a grading system in schools. SUS scores below 60 were an "F," between 60 and 69 were a "D," between 70 and 79 were a "C," between 80 and 89 were a "B," and 90 and above were an "A" [14].

3. Result

Table 1 presented the SUS score of indoor Google Maps gathered in this study. The overall, usable, and learnable SUS scores were 44.09, 44.32, and 43.18 respectively. Compared to the lower limit, mean, and upper limit of SUS scores from Sauro and Lewis [10], the SUS scores of indoor Google Maps were still below the mean score (see Fig.2). The further analysis conducted by mapping to the SUS score of indoor Google maps with the SUS norm provided Bangor, et al. [13][14] As presented at Fig.3, SUS score of indoor Google maps was considered as unacceptable. The overall SUS score of 44.09 was equivalent to the "F" in letter grade and "OK" on adjective ratings.

Table 1. Indoor Google Maps' SUS Scores.

	Question	Strongly Disagree	1	2	3	4	5	Strongly Agree	Score
1	I think that I would like to use this system frequently.								3.45
2	I found the system unnecessarily complex.								4.41
3	I thought the system was easy to use.								3.00
4	I think that I would need the support of a technical person to be able to use this system.								3.05
5	I found the various functions in this system were well integrated.								2.86
6	I thought there was too much inconsistency in this system.								3.32
7	I would imagine that most people would learn to use this system very quickly.								2.95
8	I found the system very cumbersome to use.								3.36
9	I felt very confident using the system.								3.00
10	I needed to learn a lot of things before I could get going with this system.								3.50

Subscale	Items	SUS Score
Overall	All	44.09
Usable	1-3, 5-9	44.32
Learnability	4 & 10	43.18

Figure 2. The overall, usable, and learnable SUS Scores of Indoor Google Maps compared to lower limit, mean, and upper limit from Sauro & Lewis [10].
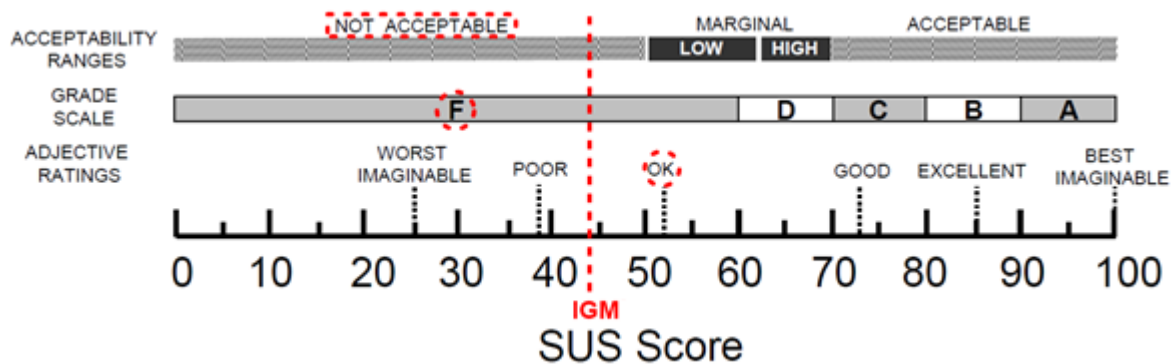
Figure 3. The overall SUS score of indoor Google Maps (IGM) on acceptability range, school grading scale and adjective ratings proposed by Bangor et al. [13][14].

4. Discussion and conclusion

In general, the relatively low SUS score of indoor Google Maps indicated the need of further improvement of the application. Although participants were likely agree that they will need the application frequently in the future (item 1), they found that the indoor Google Maps was unnecessary complex (item 2). Most participants also thought that they need to learn a lot of things before they could operate the app (item 10) which made them to think that they may need to get support of a technical person (item (4). Furthermore, the app was also considered as cumbersome to use (item 8) by most of participants. Table 2 also presented the SUS score of indoor Google Maps was below several well-known everyday products', such as Excel, GPS, Power Point Presentation (PPT), Word, and iPhone [12]. Moreover, the SUS score of indoor Google Maps was way below two other applications from Google (i.e., Gmail and Google search).

Table 2. SUS Scores of everyday products.

Everyday products	SUS score
Indoor Google Maps	44.09
Excel	56.5
GPS	70.8
PPT	74.6
Word	76.2
iPhone	78.5
Gmail	83.5
Google search	93.4

Furthermore, the age range of participants recruited in this study was 20-22 years old or grouped as millennial generation. It is commonly known that people with this age range are very familiar with digital media. Thus, if they still get difficulty in operating the indoor Google Maps, there is a chance that older people from previous generations (i.e., generation X, Y, baby boomers) will face more issues in operating indoor Google map. It is a note for the app developer to improve the quality of the interface so that it will accelerate the learning process as well as considering several learning limitations of older population.

From the observation during the participants conducted the four experiment tasks, the difficulties might rise from several issues such as inaccurate user positioning, wrong route recommendation, poor information arrangement, hidden place/business descriptions, and ineffective markers in the maps. Future study is needed to formulate the critical design criteria for an indoor map application as well as recommendations to improve its usability level. The future study should also incorporate other usability

evaluation methods and recruiting larger number of participants with more diverse educational levels and/or age groups.

5. References

[1]   McDonough W 2000 *United States of America Patent No. 6092076*

[2]   Sullivan M 2012 *A brief history of GPS* (http://www.pcworld.com/article/2000276/a-brief-history-of-gps.html)

[3]   Fredrick H 2017 *Why Doesn't GPS Work Inside a Building?* (http://techin.oureverydaylife.com/doesnt-gps-work-inside-building-18659.html)

[4]   IndoorAtlas 2016 *The Rise of Indoor Positioning, A 2016 Global Research Report On The Indoor Positioning Market*

[5]   Int. Organization for Standardization 1998 ISO 9241-11:1998(en) *Ergonomic requirements for office work with visual display terminals (VDTs) — Part 11: Guidance on usability*

[6]   Ohazama C 2011 *Go indoors with Google Maps 6.0 for Android* (http://googlemobile.blogspot.co.id/2011/11/go-indoors-with-google-maps-60-for.html)

[7]   Chi Z 2014 *Towards A Large Scale Indoor Localization Service with Crowdsensing Indoor Map Generation* (Nanyang: Nanyang Technological University)

[8]   Deliusno 2015 *Google Maps Sediakan Peta Dalam Gedung di Indonesia* (http://tekno.kompas.com/read/2015/12/09/10130037/Google.Maps.Sediakan.Peta.Dalam.Gedung.di.Indonesia)

[9]   Nunnally J 1978 *Psychometric Theory* (New York: McGraw-Hill)

[10]   Sauro J and Lewis J 2009 *Correlations among prototypical usability metrics: Evidence for the construct of usability* (Boston: ACM) p 1609-18

[11]   Lewis J R and Sauro J 2009 *The factor structure of the System Usability Scale. In: Kurosu, M. (Ed.), Human Centered Design, HCII 2009* Springer-Verlag, Heidelberg, Germany pp 94–103.

[12]   Sauro J and Lewis J R 2016 *Quantifying the user experience: Practical statistics for user research*. Morgan Kaufman n.

[13]   Bangor A, Kortum P T and Miller J T 2008 A*n empirical evaluation of the system usability scale. Intl. Journal of Human–Computer Interaction* **24**(6) pp 574-94

[14]   Bangor A, Kortum P T and Miller J T 2009 *Determining what individual SUS scores mean: adding an adjective rating scale. J. Usability* Stud. **4**(3) pp 114–23