

Assessing the usability of the NDCDB checklist with Systematic Usability Scale (SUS)

N Z A Halim^{1,2}, S A Sulaiman¹, K Talib¹ and M N Isa²

¹Centre of Studies in Surveying Science and Geomatics, Faculty of Architecture, Planning and Survey, University Technology MARA, Shah Alam, Selangor, Malaysia

²Department of Survey and Mapping Malaysia, Kuala Lumpur, Malaysia

nurzurairah@gmail.com

Abstract. This paper explains the process of assessing the usability of the National Digital Cadastral Database (NDCDB) Checklist; which was developed in a more extensive research exercise with the aim to investigate the significance and usability of NDCDB for the use of multiple spatial land-based analysis. System Usability Scale or SUS was used to determine the perceived usability of the NDCDB Checklist developed to aid users to correctly optimise the National Digital Cadastral Database or NDCDB. Eighteen participants from relevant geospatial domains were invited to test the usability of the checklist through a remote asynchronous testing. The overall SUS score of the NDCDB Checklist was 75.1, which is defined as “Acceptable” under the SUS acceptability range. The SUS score was then extracted to identify additional information of Learnability and Usability components of which both resulted in 68.8 and 76.7 respectively. The SUS score indicates that the Usability component of the NDCDB Checklist to be acceptable while the Learnability component to be marginally acceptable. As a result, the NDCDB Checklist is considered fit and appropriate to be used by stakeholders, with high usability and marginal learnability in aiding land-based spatial analysis. The benefit of the NDCDB Checklist will encourage proper utilisation of the NDCDB for other spatial analysis aside land-based spatial analysis.

1. Introduction

A person is considered spatially enabled when one can interpret and critically reflect on spatial information regarding land and people relationship. The person should be able to link maps and other spatial information, analyse their surroundings (location) with available geoinformation, which in result, enables the person to become more creative in making decisions [1] and better associate the decision with sustainability [2]. The NDCDB is described as the most spatially accurate database as far as the land-related database is the concern [3]. It was developed to replace the State Digital Cadastral Database (PDUK), which was initially used for the internal usage of the Department of Survey and Mapping Malaysia (JUPEM). The usage of PDUK was discontinued with the implementation of eKadaster in 2010, aside from its non-geocentric and GIS limitation characteristics. Although primarily used for survey works, NDCDB is significant particularly when the land and people relationship is the concern of the spatial analysis [4]. Unfortunately, no aiding tool is available to assist NDCDB data handling for NDCDB users to refer to when performing the analysis process. In addition, the growing numbers of casual GIS users and easy access to GIS software especially open-



Content from this work may be used under the terms of the [Creative Commons Attribution 3.0 licence](https://creativecommons.org/licenses/by/3.0/). Any further distribution of this work must maintain attribution to the author(s) and the title of the work, journal citation and DOI.

sourced ones may lead to the erroneous adoption of NDCDB for spatial analysis. Due to this, the analysis's reliability may become questionable when the data handling is perceived to be improperly done [5].

1.1 Significance of Checklist

Unlike other cognitive aids or protocols, checklists can be described as a sort of guideline in between an informal cognitive aid to a rigid protocol. A checklist is a mnemonic device that enables users to perform repetitive activities that include either to verify a list of activities or collect data in an orderly and systematic flow [6]. The checklists can be seen widely used in industries that require operation procedures including aviation safety [7-10], medical and critical care practice [11-15], surgical operations [16-18], evaluation system [6, 19, 20], product manufacturing and software engineering [10, 20, 21], with the aim to reduce human errors, aid decision makings, performance improvement and best practice adherence. Apart from that, checklists are used to minimise the influence of cognitive biases such as familiarity or rule of thumbs and to rectify knowledge-based mistakes [14]. Importantly, the checklist can democratise knowledge [12]. Furthermore, like most fields, the geospatial domain is infused with jargons and many ways of describing the same thing. As such translation errors are impending to one NDCDB user to another NDCDB user. Therefore, a checklist on the adoption of NDCDB for land-based spatial analysis is crucial to be developed so the benefits of the checklist described earlier can be benefited, including to improve the reliable translation of information to the same knowledge. Consequently, the information in the checklist developed, namely the NDCDB Checklist, can be replicated and disseminated [14] among NDCDB users.

The development of the NDCDB Checklist is not detailed out in this paper. However, for the purpose to overview the checklist development, Figure 1 depicts the overall NDCDB Checklist development concept framework. The objective of the NDCDB Checklist is to assist NDCDB users in NDCDB data handling, especially during land-based spatial analysis, to ensure the NDCDB is optimally optimised so better judgement can be made based on the land-related spatial analysis result. The NDCDB Checklist was developed by integrating the findings of the Delphi technique and multi-case study on the significance and usage of NDCDB for land-based spatial analysis.

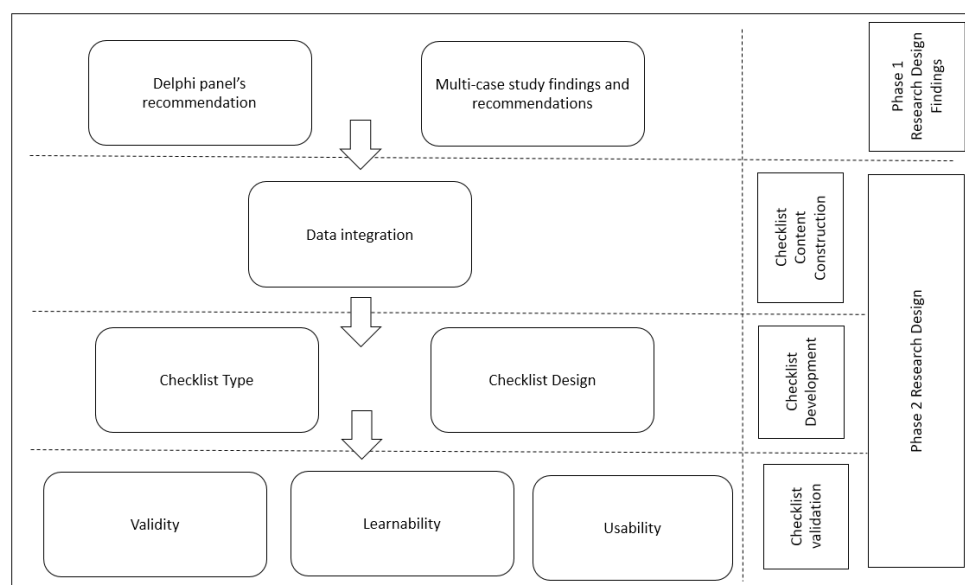


Figure 1. NDCDB Checklist Development Framework

1.2 Checklist usability assessment

The checklist should be assessed for its usability before it is broadly implemented. Usability is an extent to which a product can be used by a specific user to achieve a specific goal with effectiveness,

efficiency, and satisfaction in a specific context of use [22]. In this study, the context of usability adopted the definition from the International Standard Operations, where usability is described as the extent to which the NDCDB checklist can be used and learnable [20] by NDCDB users to achieve accurate result with effectiveness, efficiency, and satisfaction in the land-based spatial analysis. The reliability of the usability and potential risks of a checklist can be assessed by; i) testing different real-life scenarios in a simulated environment, ii) heuristic evaluation by a human factors/usability testing expert, or iii) subjective evaluation by potential users through interviews, focus groups, and surveys [12].

1.3 System Usability Scale (SUS)

The System Usability Scale method or SUS was developed by Brooke [23] to administer the overall assessment of a usability study. SUS is a self-administered instrument, composed of ten statements that are scored on a five-point Likert scale on the level of agreement with “1” indicating strongly disagree and “5” representing strongly agree. Literature have shown that SUS had been used to evaluate a wide variety of product and interface types [24] from safety signs [22], guidelines [25], websites [26], scholarly repositories [27], printed documents [28] to marketing and psychology [29]. The attractive attributes of SUS have made it an excellent choice for general usability testing compared to other usability evaluation methods available [30], such as direct access, quick and easy to administer and perform the survey. For that reason, this study adopted SUS to evaluate the usability of the NDCDB Checklist developed.

2. Research Methodology

Taking cues from established researchers on assessing the usability of a product [25, 26, 31, 32], the following research methodology was applied and depicted in Figure 2.

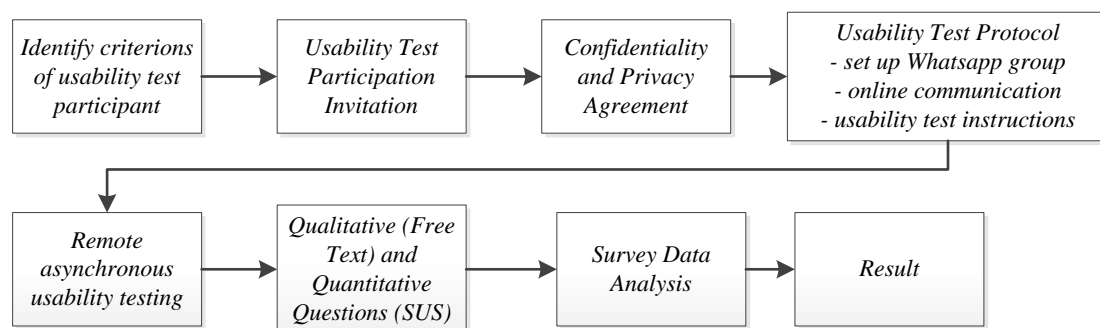


Figure 2. NDCDB Checklist Usability Test Process

2.1 Usability Test Participants

Like previous research [33], a purposive sampling of end users was required to test the usability of the NDCDB Checklist. The usability test took place subsequently upon obtaining the NDCDB Checklist's content validation from six subject matter experts related to the spatial analysis domain. Consequently, twenty targetted end users (either existing or potential users) were identified to participate the remote asynchronous usability testing. These participants were selected based on their professional background, their experience with handling NDCDB data and years involved in the related spatial analysis domain. Out of the twenty targeted end users, two had to be withdrawn due to other commitments. Nevertheless, the number of participants still exceeded the minimum number of twelve participants for a reliable SUS result [34]. The demographics of the final NDCDB Checklist usability test participants is as shown in Table 1.

2.2 Usability Test Protocol and Testing

In this study, the SUS statements were slightly modified where the word ‘system’ is replaced with ‘checklist’, and the word cumbersome in statement 8, SUS was replaced with ‘awkward’. Since the participants were heterogeneous, the asynchronous remote testing approach was conducted. The approach allowed participants to take part in the process from their natural environments or office premises, using their personal space to keep the test conditions natural and reduce logistic costs [31]. To ensure reliability, a usability test protocol was set up and applied throughout the asynchronous remote testing. The test protocol included that all communications were through online communication, and a Whatsapp group was created to ease queries and feedbacks. The usability test participants were instructed to simulate the NDCDB Checklist and immediately scored the SUS statements. Participants were repeatedly reminded of the alternate nature of the SUS statements (positive and negative) to avoid the occurrence of unintended responses due to user’s assumption of positively worded on all SUS statements. Additional comments were available for the participant to provide any additional feedback.

Table 1. Demographics of the NDCDB usability test participants

Demographic factors	Response	Numbers
Gender	Male	10
	Female	8
Group profession	Geomatics and Land Survey	5
	Land administrator / Local authority / Town planner	4
	GIS system administrator/developer	5
	Academia	4
Job experience (years)	< 10 years	5
	11 – 15 years	8
	16 – 20 years	5
NDCDB User	Directly	9
	Indirectly	9

2.3 SUS score method and indicator

The SUS overall score is calculated based on the SUS calculation formula [23], where each statement’s score contribution will range from 0 to 4. For a positive SUS statement, the score contribution is the scale position minus 1; while a negative SUS statement, the score contribution is five minus the scale position. The sum of the scores is multiplied by 2.5 to obtain the overall value of the SUS statements. To determine the *Usability* and *Learnability* component from the overall SUS statements, [32] established in their research the multiplying factors for SUS summed score contributions as 3.125 and 12.5, respectively. It should be noted that SUS scores are not percentile. According to [23], 68 is considered above average SUS score, and any SUS score below 68 is described as below average. In the acceptability range indicator, SUS scores less than 50 are judged as unacceptable, while scores between 50 and 70 are marginally acceptable, with 64 to 70 scores are considered as marginally high and scores of 50 to 63 as marginally low. SUS scores above 70 are judged as acceptable [22, 24].

3. Result

3.1 Overall SUS score

Responses to the individual SUS statements are depicted in Table 2. Based on the SUS calculation formula, the overall mean SUS score for the NDCDB Checklist is 75.1, while the *Learnability* and *Usability* components are 68.8 and 76.7, respectively.

3.2 Demographic relationship with SUS Score

The relationship of the participant's demographic information as depicted in Table 1 and the SUS score was conducted by optimising the Pearson Correlation Coefficient with SPSS version 23. Table 3 shows the result of all four demographic variables of 'Gender', 'Group profession', 'Job experience' and 'NDCDB user' correlation with the SUS overall score. The result showed 'Job experience', and 'NDCB users' have very strong positive and negative correlation with statistical significance towards the SUS overall score, with $r=0.827$, $p < 0.05$ and $r=-0.716$, $p < 0.05$ respectively. There is also a strong negative relationship between 'Job experience' and 'NDCDB user' variables with $r=-0.596$. However, there is no inconclusive evidence about the significance of the association between the variables, as 'p' value is more than 0.05.

Table 2. Overall SUS score

User	SUS Statements										Overall Score SUS	SUS Component	
	S1	S2	S3	S4	S5	S6	S7	S8	S9	S10		Learnability	Usability
1	4	2	4	2	4	2	5	2	4	2	77.5	75	78.1
2	5	2	5	2	5	2	5	2	5	2	87.5	75	90.6
3	5	2	5	2	5	2	5	2	5	2	87.5	75	90.6
4	4	2	4	2	4	2	4	2	4	3	72.5	62.5	75.0
5	4	1	4	2	4	1	4	1	4	2	82.5	75	84.4
6	4	2	4	2	4	2	5	2	4	2	77.5	75	78.1
7	5	2	5	3	5	2	5	2	5	2	85.0	62.5	90.6
8	5	3	5	2	5	3	5	3	5	3	77.5	62.5	81.3
9	4	2	4	2	4	2	4	2	4	2	75.0	75	75.0
10	4	2	4	2	4	2	4	2	4	2	75.0	75	75.0
11	4	2	4	2	4	2	5	2	4	3	75.0	62.5	78.1
12	5	2	5	2	5	2	4	2	5	2	85.0	75	87.5
13	5	1	5	1	5	1	5	1	5	1	100.0	100	100.0
14	4	1	4	1	4	1	4	2	5	1	87.5	100	84.4
15	5	2	5	2	5	2	5	2	5	2	87.5	75	90.6
16	5	1	5	1	5	1	5	1	5	2	97.5	87.5	100.0
17	4	2	4	2	4	2	4	2	4	2	75.0	75	75.0
18	5	1	5	1	5	1	5	1	5	2	97.5	87.5	100.0
Overall Mean SUS Score											75.1	68.8	76.7

Table 3. Pearson correlation covariance of demographic variables and SUS score

Correlations						
Variables		User	Group	Job Experience	SUS Score	Gender
NDCDB user	Pearson Correlation	1	.299	-.596**	-.716**	.000
	Sig. (2-tailed)		.229	.009	.001	1.000
Group	Pearson Correlation	.299	1	.200	-.061	-.056
	Sig. (2-tailed)	.229		.426	.809	.826
Job Experience	Pearson Correlation	-.596**	.200	1	.827**	-.300
	Sig. (2-tailed)	.009	.426		.000	.226
SUS Score	Pearson Correlation	-.716**	-.061	.827**	1	-.339
	Sig. (2-tailed)	.001	.809	.000		.169
Gender	Pearson Correlation	.000	-.056	-.300	-.339	1

Variables	Correlations				
	User	Group	Job Experience	SUS Score	Gender
Sig. (2-tailed)	1.000	.826	.226	.169	

**. Correlation is significant at the 0.05 level (2-tailed).

4. Discussion

The SUS score results indicated the NDCDB Checklist to be acceptable for its purpose of guiding users when adopting NDCDB for multiple land-based spatial analysis. The high mean value of the *Usability* and *Learnability* components of the NDCDB Checklist qualifies the NDCDB Checklist to be described according to [24] as an ‘excellent’ aiding tool for NDCDB users to use when adopting NDCDB for land-based spatial analysis purposes; and a ‘good’ aiding tool to learn the NDCDB data handling exercise during land-based spatial analysis process. Summative content analysis conducted to the additional comments of participants on the NDCDB Checklist also supported the overall SUS score result. 73% of the participant provided positive feedbacks on the NDCDB Checklist developed, that advocated the checklist; i) can increase NDCDB adoption steps compliance, ii) can ensure better judgement of the spatial analysis result; iii) can be distributed to NDCDB users, and iv) beneficial tool to promote the correct adoption of NDCDB for land-based spatial analysis.

Apart from that, the study has also established that individuals who have exposure to NDCDB provided high mean SUS overall score and SUS scores decreased with users who have limited exposure to NDCDB. A very strong statistically significant correlation between NDCDB user type and SUS scores exist to support the claim. Individuals with extensive job-related experience either in the field of geomatics and land survey, land administration and town planning, GIS system administration and development, or academia with related geospatial expertise also have a very strong statistically significant correlation with SUS overall score. From the result, it can be summarised that experienced job-related individuals who have exposure to NDCDB may find the NDCDB Checklist useful and learnable for multiple land-based spatial analysis.

5. Conclusion

Overall the study has successfully determined the perceived usability of the NDCDB Checklist developed for land-based spatial analysis. The NDCDB Checklist can be described as an “excellent” tool to assist NDCDB users when optimising NDCDB for land-based spatial analysis, aside as a “good” tool for NDCDB users to learn about steps compliance, rectifying knowledge-based mistakes and democratise knowledge on NDCDB data handling. By confirming the NDCDB Checklist’s usability, future works can be planned to disseminate the checklist to NDCDB users. However, it should be noted that the checklist should be reviewed and amended accordingly, to remain relevant. The checklist can be adapted for land-based spatial analysis by potential organisations to suit their clientele requirement. Thus, can improve and support the ease of doing land business and dealings for sustainable growth. It is hope, with the NDCDB Checklist emplaced, potentials of the NDCDB drawn from the overall research context can be tapped by users such as; i) optimising all the NDCDB layer formats for a holistic spatial analysis result; ii) optimising all the NDCDB’s additional layers to complement the ‘missing’ land parcels; iii) optimising NDCDB as the most spatially accurate land-based database for GIS applications; iv) optimising the spatial existence of NDCDB’s additional layers for planning purposes; and v) the NDCDB is updated almost real time, making the data is relevant to the cut-off-date. It will be wasteful and exhausting resources if the NDCDB is not well optimised.

Acknowledgements

The authors would like to thank Universiti Teknologi MARA, JUPEM, and all related agencies for providing valuable information for this study.

References

- [1] FIG: 'Spatially Enabled Society' (International Federation of Surveyors, 2012. 2012)
- [2] Steudler, D.: 'The Six Fundamental Elements for Spatially Enabled Societies From a Fit-For-Purpose Perspective'. Proc. World Bank Conference on Land and Poverty, Washington DC2016 pp. Pages
- [3] Halim, N.Z.A., Sulaiman, S.A., Talib, K., and Ng, E.G.: 'Identifying the relevant features of the National Digital Cadastral Database (NDCDB) for spatial analysis by using the Delphi Technique'. Proc. International Conference on Research Methodology for Built Environment and Engineering 2017, Shah Alam, Malaysia2017 pp. Pages
- [4] Halim, N.Z.A., Sulaiman, S., Talib, K., Yusof, O., Wazir, M., and Adimin, M.: 'Identifying the role Of National Digital Cadastral Database (NDCDB) in Malaysia and for land-based spatial analysis', International Archives of the Photogrammetry, Remote Sensing & Spatial Information Sciences, 2017, 42
- [5] Chan, K.-T.: 'Introduction to Geographic Information Systems' (McGraw Hill Education 2016, 8th edn. 2016)
- [6] Martz, W.: 'Validating an evaluation checklist using a mixed method design', Evaluation and Program Planning, 2010, 33, (3), pp. 215-222
- [7] Jiménez, J.A., Merodio, J.A.M., and Sanz, L.F.: 'Checklists for compliance to DO-178C and DO-278A standards', Computer Standards & Interfaces, 2017, 52, (Supplement C), pp. 41-50
- [8] Hales, B.M., and Pronovost, P.J.: 'The checklist—a tool for error management and performance improvement', Journal of Critical Care, 2006, 21, (3), pp. 231-235
- [9] Haugen, A.S., Bakke, A., Løvøy, T., and Søfteland, E.: 'Preventing Complications: The Preflight Checklist', European Urology Focus, 2016, 2, (1), pp. 60-62
- [10] Huang, F., and Liu, B.: 'Software defect prevention based on human error theories', Chinese Journal of Aeronautics, 2017, 30, (3), pp. 1054-1070
- [11] Christman, A., Schrader, S., John, V., Zunt, S., Maupome, G., and Prakasam, S.: 'Designing a safety checklist for dental implant placement: A Delphi study', The Journal of the American Dental Association, 2014, 145, (2), pp. 131-140
- [12] Winters, B.D., Gurses, A., Lehmann, H., Sexton, J., Jai Rampersad, C., and Pronovost, P.: 'Clinical review: Checklists - translating evidence into practice' (2009. 2009)
- [13] Fausett, M.B., Propst, A., Van Doren, K., and Clark, B.T.: 'How to develop an effective obstetric checklist', American Journal of Obstetrics and Gynecology, 2011, 205, (3), pp. 165-170
- [14] Kramer, H.S., and Drews, F.A.: 'Checking the lists: A systematic review of electronic checklist use in health care', Journal of Biomedical Informatics, 2017, 71, (Supplement), pp. S6-S12
- [15] Montero-Odasso, M., Levinson, P., Gore, B., Epid, D., Tremblay, L., and Bergman, H.: 'A Flowchart System to Improve Fall Data Documentation in a Long-Term Care Institution: A Pilot Study', Journal of the American Medical Directors Association, 2007, 8, (5), pp. 300-306
- [16] Keogh, I., O'Duffy, F., and O'Connor, P.: 'Surgical checklists: the human factor', Patient safety in surgery, 2013
- [17] Viswanath, A., Balint, A., Johnson, R.E., Rosenberg, M.B., and Oreadi, D.: 'Surgical Safety Checklists Are Underutilized in Ambulatory Oral and Maxillofacial Surgery', Journal of Oral and Maxillofacial Surgery, 2017
- [18] Jing, J., and Honey, M.L.L.: 'Using a Checklist in Robotic-Assisted Laparoscopic Radical Prostatectomy Procedures', AORN Journal, 2016, 104, (2), pp. 145-152
- [19] van Voorn, G.A.K., Verburg, R.W., Kunseler, E.M., Vader, J., and Janssen, P.H.M.: 'A checklist for model credibility, salience, and legitimacy to improve information transfer in environmental policy assessments', Environmental Modelling & Software, 2016, 83, (Supplement C), pp. 224-236

- [20] Oztekin, A., Kong, Z.J., and Uysal, O.: 'UseLearn: A novel checklist and usability evaluation method for eLearning systems by criticality metric analysis', *International Journal of Industrial Ergonomics*, 2010, 40, (4), pp. 455-469
- [21] Quinn, S.D., Souppaya, M., Cook, M., and Scarfone, K.: 'National Checklist Program for IT Products—Guidelines for Checklist Users and Developers', NIST special publication, 2011, 800, pp. 70
- [22] Ng, A., Lo, H., and Chan, A.: 'Measuring the Usability of Safety Signs: A use of system usability scale (SUS)', in Editor (Ed.)^(Eds.): 'Book Measuring the Usability of Safety Signs: A use of system usability scale (SUS)' (IAENG Hong Kong, 2011, edn.), pp. 1296-1301
- [23] Brooke, J.: 'SUS-A quick and dirty usability scale': 'Usability evaluation in industry' (Taylor and Francis, 1996), pp. 189-194
- [24] Bangor, A., Kortum, P., and Miller, J.: 'Determining what individual SUS scores mean: Adding an adjective rating scale', *Journal of usability studies*, 2009, 4, (3), pp. 114-123
- [25] Khodambashi, S., and Nytrø, Ø.: 'Usability Evaluation of Published Clinical Guidelines on the Web: A Case Study', in Editor (Ed.)^(Eds.): 'Book Usability Evaluation of Published Clinical Guidelines on the Web: A Case Study' (2016, edn.), pp. 140-145
- [26] McLellan, S., Muddimer, A., and Peres, S.C.: 'The effect of experience on System Usability Scale ratings', *Journal of Usability Studies*, 2012, 7, (2), pp. 56-67
- [27] Klug, B.: 'An Overview of the System Usability Scale in Library Website and System Usability Testing', *Weave: Journal of Library User Experience*, 2017, 1, (6)
- [28] Grudniewicz, A., Bhattacharyya, O., McKibbin, K.A., and Straus, S.E.: 'Redesigning printed educational materials for primary care physicians: design improvements increase usability', *Implementation Science*, 2015, 10, (1), pp. 156
- [29] Sauro, J., and Lewis, J.R.: 'When designing usability questionnaires, does it hurt to be positive?', in Editor (Ed.)^(Eds.): 'Book When designing usability questionnaires, does it hurt to be positive?' (ACM, 2011, edn.), pp. 2215-2224
- [30] Martins, A.I., Rosa, A.F., Queirós, A., Silva, A., and Rocha, N.P.: 'European Portuguese Validation of the System Usability Scale (SUS)', *Procedia Computer Science*, 2015, 67, (Supplement C), pp. 293-300
- [31] Alghamdi, A.S., Al-Badi, A., Alroobaea, R., and Mayhew, P.: 'A comparative study of synchronous and asynchronous remote usability testing methods', *International Review of Basic and Applied Sciences*, 2013, 1, (3)
- [32] Lewis, J.R., and Sauro, J.: 'The factor structure of the system usability scale', in Editor (Ed.)^(Eds.): 'Book The factor structure of the system usability scale' (Springer, 2009, edn.), pp. 94-103
- [33] Burnett, G., and Ditsikas, D.: 'Personality as A-Criterion for Selecting Usability Testing Participants' (2006. 2006)
- [34] Dumas, J.S., and Loring, B.A.: 'Moderating usability tests: Principles and practices for interacting' (Morgan Kaufmann, 2008. 2008)