# Metrics and Attributes for Assessing the Stability of Handheld Application Usage

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**ABSTRACT**

This study is designed to identify metrics and attributes for assessing the stability of handheld application usage. The objectives of this study are to identify: 1) what stability measures are really important for assessing the stability of handheld application usage; 2) what is the association of the identified stability measures in order to assess the stability of handheld application usage; 3) what is the relationship of the identified stability measures in order to assess the stability of handheld application usage; and 4) what is the rank order of these stability measures towards assessing the stability of handheld application usage. As a result, a total number of eleven stability measures (i.e. eight stability metrics and three stability attributes) were identified as contributed towards assessing the stability of handheld application usage.



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## 1. INTRODUCTION

The term stability in the perspective of useful and usable can be defined as the degree to which making the condition of software of being stable or steady in relation to correct or complete as well as effort and time, that reflects the real world object or event being described, based on the users' needs and requirements[1][2]. Over the past few decades, several researches for assessing and evaluating stability of software have been mentioned. The international standard, ISO/IEC 9126, described stability as quality sub attribute to software that bare on the provision of the ease with which a product can be maintained in order to improve reliability [2]. In the other hand, stability correlates with the metrics which measure attributes of the software that indicate about the risk of unexpected effects as a result of modification [3][4][5].Some researchers also classify stability as an essential characteristic for evaluating and assessing the usability of software. Stability normally plays as an important factor for all software usability elements with which the fewer the interaction failures and times taken to complete tasks that are observed the more stable an application is [6][7][8][9]. Within the domain of handheld software, several researchers have proposed to explore the concept of stability [10][11][12][13]. Although research on these previous studies provide a lot of useful information in understanding stability, there are however lack of effort being given to view stability measures in assessing the stability of handheld application usage. In this regard, there is a strong reason to initiate a new research to identify measures for assessing the stability of handheld application usage. The results presented not only reveals the stability between handheld users and its application but also provide a better understanding in the relationship of these factors. In addition, the findings can be established as a concrete evaluation technique for assessing the stability of handheld application usage.

## 2. RESEARCH METHOD

From the review of previous studies [14][15][16][17][18], a total number of eight stability metrics were identified as contributed towards assessing the stability of handheld application usage. These eight stability metrics were classified into three main stability attributes of Information Speed, Lateral Position and Optimal Solution. The definition of each stability metrics and attributes is as depicted below (Table 1). The classification of each metrics towards its corresponding attribute for assessing the stability of handheld application usage is as depicted below (Table 2).

Table 1. Description of stability metrics and attributes

| Stability metric | Description |
|---|---|
| Data Entered | The number of data entered correctly and completely per allocated time |
| Errors Corrected | The number of errors corrected correctly and completely per allocated time |
| Focuses Undistracted | The number of focuses undistracted correctly and completely per allocated time |
| Lines Read | The number of lines read correctly and completely per allocated time |
| Links Explored | The number of links explored correctly and completely per allocated time |
| Paths Traversed | The number of paths traversed correctly and completely per allocated time |
| Steps Navigated | The number of steps navigated correctly and completely per allocated time |
| Targets Located | The number of targets located correctly and completely per allocated time |
| **Stability attribute** | **Description** |
| Information Speed | Capability in handling information correctly and completely per allocated time |
| Lateral Position | Capability in positioning objects correctly and completely per allocated time |
| Optimal Solution | Capability in solving tasks correctly and completely per allocated time |

Table 2. Categorization of stability metrics

| Stability attribute | Stability metric |
|---|---|
| Information Speed | Data Entered |
| | Errors Corrected |
| | Lines Read |
| Lateral Position | Focuses Undistracted |
| | Targets Located |
| Optimal Solution | Links Explored |
| | Paths Traversed |
| | Steps Navigated |

In order to identify whether these stability metrics and attributes were significantly associated and related towards assessing the stability of handheld application usage, this study is designed to achieve four major objectives: 1) determining the importance of stability metrics and attributes towards assessing the stability of handheld application usage; 2) identifying the association of stability metrics and attributes for assessing the stability of handheld application usage; 3) analyzing the relationship of the identified stability metrics and attributes in order to assess the stability of handheld application usage; and 4) ranking the order of these stability metrics and attributes towards assessing the stability of handheld application usage. A questionnaire survey namely 'Investigating the Metrics and Attributes for Assessing the Stability of Handheld Application Usage' was developed to elicit the responses from the target respondents to detect which metrics and attributes need to be included in and which metrics and attributes need to be excluded from being the metrics and attributes for assessing the stability handheld application usages. This questionnaire was used to gather information about the stability experience and perception of using handheld applications among handheld application users and commanded respondents to indicate their level of agreement with a number of eight stability metrics and three stability attributes towards assessing the stability of handheld application usage. A pilot study was also conducted to confirm the validity and reliability as well as to obtain the understandings towards the construction of this questionnaires. As a result, a total number of two hundred nineteen respondents among handheld applications users were analyzed to the purpose of this study. For the number of two hundred nineteen samples, the response rate was approximately about seventy-seven percent. This percentage was considered as satisfactory in which the responses exceeded the research minimum acceptable level of fifty percent plus one. Data collected from the final questionnaire was entered on the Statistical Package for the Social Sciences (SPSS) for the analysis process. This brings together three parts of evaluation tests: 1) descriptive test; 2) association test; and 3) relationship test. The purpose for conducting descriptive test was to determine the level of importance of each stability metrics and attributes towards assessing the stability of handheld application usage. Association test was conducted to measure the amount of association of stability metrics and attributes for assessing the stability of handheld application usage. Meanwhile, the relationship test was conducted to comprehend the relationship strength between the stability metrics and its corresponding attributes in order to assess the stability of handheld application usage as well as the strength of stability attributes towards stability as a measure to assess the of handheld application usage. Each of the stability metrics and attributes were than ranked according to the highest priority to the lowest priority based on the result of the analysis of importance, association and relationship of these stability metrics and attributes towards assessing the stability of handheld applications usage. The procedure for ranking the stability metrics and attributes is by scoring the analysis results separately, with which the highest value were labeled 1, followed by the second highest value with 2 and so on. The point of each importance, association and relationship scores were then averaged and assigned to the rank order of the stability metrics and attributes. The lowest mean joint point were stated the most important readiness metrics and attributes in assessing the stability of handheld application usage while the highest presented the least important stability metrics and attributes.

## 3. RESULTS AND ANALYSIS

### 3.1. Importance of Stability Metrics and Attributes

Result of the descriptive test revealed that, in general, participants reported a different level of importance of each stability metrics and attributes towards assessing the stability of handheld application usage. In detail, result of descriptive test reported that metrics of Data Entered (N = 199), Errors Corrected (N = 170) and Lines Read (N = 170) were found significantly important towards attribute Information Speed in order to assess the stability of handheld application usage with the percentage of 90.0, 77.6 and 77.6 respectively. In addition, metrics of Focuses Undistracted (N = 128) and Targets Located (N = 129) were found slightly important towards attribute Lateral Position with the percentage of 58.5 and 58.9 for assessing the stability of handheld application usage. Results also showed that metrics of Links Explored (N = 187, 85.4%), Paths Traversed (N = 154, 70.3%) and Steps Navigated (N = 168, 76.8%) were also found highly important towards attribute Optimal Solution in assessing the stability of handheld application usage. Finally, result of the association test also stated that the attributes of Information Speed (N = 195, 89.0%), Lateral Position (N = 198, 90.4%) and Optimal Solution (N = 190, 86.7) were also found significantly important towards assessing the stability of handheld application usage. As a result, a total number of eleven stability measures (i.e. eight stability metrics and three stability attributes) were identified as important towards assessing the stability of handheld application usage (Table 3).

Table 3. Descriptive result of stability metrics and attributes

| Stability metrics | Unimportant | Undecided | Important |
|---|---|---|---|
| Data Entered | 6 (2.7) | 14 (6.4) | 199 (90.9) |
| Errors Corrected | 20 (9.1) | 29 (13.3) | 170 (77.6) |
| Focuses Undistracted | 29 (13.3) | 62 (28.2) | 128 (58.5) |
| Lines Read | 25 (11.4) | 24 (11.0) | 170 (77.6) |
| Links Explored | 7 (3.2) | 25 (11.4) | 187 (85.4) |
| Paths Traversed | 16 (7.3) | 49 (22.4) | 154 (70.3) |
| Steps Navigated | 17 (7.8) | 34 (15.5) | 168 (76.8) |
| Targets Located | 30 (13.7) | 60 (27.4) | 129 (58.9) |
| **Stability attributes** | **Unimportant** | **Undecided** | **Important** |
| Information Speed | 10 (4.6) | 14 (6.4) | 195 (89.0) |
| Lateral Position | 8 (3.7) | 13 (5.9) | 198 (90.4) |
| Optimal Solution | 10 (4.6) | 19 (8.7) | 190 (86.7) |

### 3.2. Association of Stability Metrics and Attributes

Result of association test reported that metrics of Data Entered (M = 4.52, SD = .738), Errors Corrected (M = 4.10, SD = .979) and Lines Read (M = 4.08, SD = .992) were contributed towards attribute Information Speed in order to assess the stability of handheld application usage with $p < .001$. In addition, metrics of Focuses Undistracted (M = 3.65, SD = 1.027) and Targets Located (M = 3.69, SD = 1.038) were found significantly contributed towards attribute Lateral Position with $p < .001$ for assessing the stability of handheld application usage. Results also showed that metrics of Links Explored (M = 4.25, SD = .780), Paths Traversed (M = 3.95, SD = .912) and Steps Navigated (M = 4.04, SD = .905) were also found associated and contributed towards attribute Optimal Solution in assessing the stability of handheld application usage with $p < .001$. Finally, result of the association test also stated that the attributes of Information Speed (M = 4.34, SD = .811), Lateral Position (M = 4.27, SD = .734) and Optimal Solution (M = 4.27, SD = .806) were found contributed towards assessing the stability of handheld application usage, with $p < .001$. As a result, a total number of eleven stability measures (i.e. eight stability metrics and three stability attributes) were identified as significantly associated and contributed towards assessing the stability of handheld application usage (Table 4).

### 3.3. Relationship of Stability Metrics and Attributes

Result of the relationship test revealed that there was a moderate and positive linear relationship between metrics Data Entered with the strength weight of W = .346, while metrics of Errors Corrected and Lines Read were reported having low and positive linear relationship with W = .251 and W = .298 respectively towards attribute Information Speed with $p < .001$ for assessing the stability of handheld application usage. Furthermore, results found that the coefficient value of metric Focuses Undistracted (W = .470) was moderate and having a positive linear relationship towards attribute Lateral Position with $p < .001$ towards assessing the stability of handheld application usage while in contrast, metrics Targets Located (W = .528) were also found as having high and positive linear relationship towards its corresponding attribute. In order to assess the stability of handheld application usage, metrics of Links Explored (W = .333), Paths Traversed (W = .410) and Steps Navigated (W = .385) were reported to have a moderate and positive linear relationship between attribute Optimal Solution with $p < .001$. Finally, the relationship test also indicated the

correlation strength between attributes Information Speed (W = .306), Lateral Position (W = .311) resulted having a moderate and positive linear relationship towards assessing the stability of handheld application usage with $p < .001$. However, attribute of Optimal Solution (W = .298) was revealed to have a low and positive linear relationship towards assessing the stability of handheld application usage with $p < .001$. Based on the result of the relationship test, out of the total number of eleven stability measures, seven (i.e. five stability metrics and two stability attributes) were identified having moderate and positive linear relationship, three (i.e. two stability metrics and one stability attributes) were identified having low and positive linear relationship, while only one stability matric reported having high and positive linear relationship towards measuring the stability of handheld application usage (Table 5).

Table 4. Association result of stability metrics and attributes

| Stability metrics | Mean (M) | Std Dev (SD) |
|---|---|---|
| Data Entered | 4.52 | .738 |
| Errors Corrected | 4.10 | .979 |
| Focuses Undistracted | 3.65 | 1.027 |
| Lines Read | 4.08 | .992 |
| Links Explored | 4.25 | .780 |
| Paths Traversed | 3.95 | .912 |
| Steps Navigated | 4.04 | .905 |
| Targets Located | 3.69 | 1.038 |
| Stability attributes | Mean (M) | Std Dev (SD) |
| Information Speed | 4.34 | .811 |
| Lateral Position | 4.27 | .734 |
| Optimal Solution | 4.27 | .806 |

Table 5. Relationship result of stability metrics and attributes

| Stability metrics | Weight (W) | Strength (S) |
|---|---|---|
| Data Entered | .346 | Moderate |
| Errors Corrected | .251 | Low |
| Focuses Undistracted | .470 | Moderate |
| Lines Read | .298 | Low |
| Links Explored | .333 | Moderate |
| Paths Traversed | .410 | Moderate |
| Steps Navigated | .385 | Moderate |
| Targets Located | .528 | High |
| Stability attributes | Weight (W) | Strength (S) |
| Information Speed | .306 | Moderate |
| Lateral Position | .311 | Moderate |
| Optimal Solution | .298 | Low |

### 3.4. Rank Order of Stability Metrics and Attributes

Based on the three tests conducted previously, results of metrics Data Entered, Errors Corrected and Lines Read reported that the importance point (IP) were 1, 3 and 3, association point (AP) were 1, 3 and 4 and relationship point (RP) were 5, 8 and 7 respectively towards assessing the stability of handheld application usage. Results also showed the rank order points of each tests for metric Focusses Undistracted with IP = 8, AP = 8 and RP = 2 while metric Targets Located with IP = 7, AP = 7 and RP = 1 in order to assess the stability of handheld application usage. In addition, results also showed the rank order points for each metrics of Links Explored with IP = 2, AP = 6 and RP = 5, Paths Traversed Explored with IP = 6, AP = 6 and RP = 3 as well as Steps Navigated with IP = 5, AP = 5 and RP = 4 towards assessing the stability of handheld application usage. Also based on the three tests conducted previously, results of attributes Information Speed, Lateral Position and Optimal Solution reported that the importance point (IP) were 2, 1 and 3, association point (AP) were 1, 2 and 2 and relationship point (RP) were 2, 1 and 3 respectively towards assessing the stability of handheld application usage. The rank order point of each stability metrics and attributes towards assessing the stability of handheld application usage which were based on the result of the three descriptive, association and relationship tests is as depicted in Table 6. According to the calculation of mean joint point (MJP) between importance, association and relationship, results showed that metrics of Data Entered (MJP = [1+1+5]/3 = 2.3), Errors Corrected (MJP = [3+3+8]/3 = 4.7) and Lines Read (MJP = [3+4+7]/3 = 4.7) contributed the first, third and third rank order towards assessing the stability of handheld application usage. In addition, metrics of Focuses Undistracted (MJP = [8+8+2]/3 = 6.0) and Targets Located (MJP = [7+7+1]/3 = 5.0) were found contributed at the eight and sixth place respectively towards assessing the stability of handheld application usage. Results also showed that metrics of Links Explored (MJP = [2+2+6]/3 = 3.3), Paths Traversed (MJP = [6+6+3]/3 = 5.0) and Steps Navigated (MJP = [5+5+4]/3 = 4.7) were also found contributed the second, sixth and third rank order respectively in assessing the stability

of handheld application usage. Finally, result of the mean joint point of the three importance, association and relationship tests also stated the rank order of attributes Information Speed (MJP = [2+1+2]/3 = 1.7), Lateral Position (MJP = [1+2+1]/3 = 1.3) and Optimal Solution (MJP = [3+2+3]/3 = 2.7) with second, first and third respectively towards assessing the stability of handheld application usage. The rank order point of each stability metrics and attributes towards assessing the stability of handheld application usage which were based on the mean joint point of the three descriptive, association and relationship is depicted in Table 6. The rank order of each stability metrics towards its corresponding attributes and the rank order of each attributes towards assessing the stability of handheld application usage is as depicted in Table 7.

Table 6. Rank order point based on importance, association and relationship results

| Stability metrics | Importance Point (IP) | Association Point (AP) | Relationship Point (RP) | Mean Joint Point (MJP) | Rank Order |
|---|---|---|---|---|---|
| Data Entered | 1 | 1 | 5 | 2.3 | 1 |
| Errors Corrected | 3 | 3 | 8 | 4.7 | 3 |
| Focuses Undistracted | 8 | 8 | 2 | 6.0 | 8 |
| Lines Read | 3 | 4 | 7 | 4.7 | 3 |
| Links Explored | 2 | 2 | 6 | 3.3 | 2 |
| Paths Traversed | 6 | 6 | 3 | 5.0 | 6 |
| Steps Navigated | 5 | 5 | 4 | 4.7 | 3 |
| Targets Located | 7 | 7 | 1 | 5.0 | 6 |
| Stability metrics | Importance Point (IP) | Association Point (AP) | Relationship Point (RP) | Mean Joint Point (MJP) | Rank Order |
| Information Speed | 2 | 1 | 2 | 1.7 | 2 |
| Lateral Position | 1 | 2 | 1 | 1.3 | 1 |
| Optimal Solution | 3 | 2 | 3 | 2.7 | 3 |

Table 7. Rank order of stability metrics and attributes

| Stability metrics | Rank Order |
|---|---|
| Data Entered → Information Speed | 1 (1) |
| Errors Corrected → Information Speed | 2 (3) |
| Lines Read → Information Speed | 3 (3) |
| Targets Located →Lateral Position | 1 (6) |
| Focuses Undistracted →Lateral Position | 2 (8) |
| Links Explored → Optimal Solution | 1 (2) |
| Steps Navigated → Optimal Solution | 2 (3) |
| Paths Traversed → Optimal Solution | 3 (6) |
| Stability attributes | Rank Order |
| Lateral Position → Stability | 1 (1) |
| Information Speed → Stability | 2 (2) |
| Optimal Solution → Stability | 3 (2) |

## 4. CONCLUSION

The results presented not only reveals the stability measures between handheld users and its application but also provide a better understanding in the relationship of these factors. In addition, these measures are valuable as an alternative design guideline or technique to be used for measuring and ensuring the stability of handheld application usage. For the future, it is recommended to establish these findings as a concrete evaluation technique for assessing the stability of handheld application usage. With extensive research, stability measures might change and additional new criteria could be included in the future work.

## REFERENCES

[1] M. E. Fayad and A. Altman, "An introduction to software stability: Studying the design and development that produces stable (or unstable) software", *Communications of the ACM*, Vol. 44, No. 9, pp 95 – 98, 2001.

[2] ISO/IEC 9126, "Software engineering – Product quality. Part 1: 2001 – Parts 2 to 4", *International Organization for Standardization*, Geneva, 2004.

[3] O. M. Khaled. and H. M. Hosny, "A quality attribute-based approach for applying performance design patterns", *International Journal of Software Engineering*, Vol. 1, No. 1, pp 101 – 131, 2008.

[4] M. D. Hina, "Quality attribute – Driven software architecture of a pervasive multimodal computing system', *AMAIUB – CCS Research Journal*, Vol. 2, No. 1, 2012.

[5] A. K. Sharma and H. Singh, "The software quality assurance framework for CBSD", *International Journal of Advanced Research in Computer Science and Software Engineering*, Vol. 2, No. 11, pp 161 – 170, 2012.

[6] M. Hassenzahl, "The interplay of beauty, goodness, and usability in interactive products", *Human-Computer Interaction*, Vol. 19, No. 4, pp 319 – 349, 2004.

[7] W. Min, L. Jie, J. Hong, L. Ning, W. Wenzhao and H. Zhenjie, "Evaluation on influence factor of mechanism usability based on analytical prey incidence process", Proceedings of the 2011 International Conference on

Consumer Electronics, Communications and Networks (CECNet), pp 2200 – 2203, 2011.
[8] W. Pan, "Quantifying the stability of software systems via simulation in dependency networks", *World Academy of Science, Engineering and Technology*, Vol. 60, pp 1513 – 1520, 2011.
[9] A. Tuch, S. Roth, K. Hornbæk, K. Opwisa, and J. Bargas-Avilaa, "Is beautiful really usable? Toward understanding the relation between usability, aesthetics, and affect in HCI", *Computers in Human Behavior*, Vol. 28, No. 5, pp 1596 – 1607, 2012.
[10] Z. Li, and X. Bai, "Influences of perceived risk and system usability on the adoption of mobile banking service", Proceedings of the Third International Symposium on Computer Science and Computational Technology (ISCSCT), pp 51 – 54, 2010.
[11] P. Yang, G. Qin, Y. Yan, H. Wang and L. Zhang, "On the channel usability of wireless mesh networks: When stability plays with you", *International Journal of Ad Hoc and Ubiquitous Computing*, Vol. 8, No. 1/2, pp 64 – 77, 2011.
[12] H. Nicolau and J. Jorge, "Touch typing using thumbs: Understanding the effect of mobility and hand posture", Proceedings of the 2012 ACM Annual Conference on Human Factors in Computing Systems (CHI 2012), New York, USA, ACM, pp 2683 – 2686, 2012.
[13] R. Oliveira, M. Cherubini and N. Oliver, "Influence of usability on customer satisfaction: A case study on mobile phone services", Proceedings of the I–UxSED CEUR Workshop, pp 14 – 19, 2012.
[14] A. F. A. Fadzlah and A. Deraman, "Review of Current Studies in Measuring Usability – Part I", Proceedings of the 2nd International Information, Communication Technology Seminar (ICTS`06), Surabaya, Indonesia, 2006.
[15] A. F. A. Fadzlah and A. Deraman, "Review of Current Studies in Measuring Usability – Part II", Proceedings of the 2nd Malaysian Software Engineering Conference (MySEC`06), Kuala Lumpur, Malaysia, 2006.
[16] A. F. A. Fadzlah and A. Deraman, "Review of Current Studies in Measuring Usability – Part III", Proceedings of the International Conference on Science and Technology: Application in Industry and Education (ICSTIE`06), Penang, Malaysia, 2006.
[17] A. F. A. Fadzlah and A. Deraman, "Review of Current Studies in Measuring Usability – Part IV", Proceedings of the Computer Science, Mathematics Symposium (CSMS`06), Terengganu, Malaysia, 2006.
[18] A. F. A. Fadzlah and A. Deraman, "Towards the Development of a Handheld Computing Software Usability Metrics Model: An Initial Finding on the Needs of Developing Handheld Computing Software Usability Metrics Model", Proceedings of the International Conference on Intelligent Systems (ICIS`05). Kuala Lumpur, Malaysia, 2005.

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