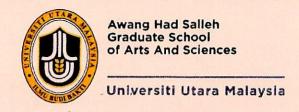Universiti Utara Malaysia

A USABILITY EVALUATION MODEL FOR ACCESSIBLE MOBILE E-BOOK APPLICATIONS FOR THE VISUALLY IMPAIRED

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DOCTOR OF PHILOSOPHY
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Abstrak

Penilaian memainkan peranan penting dalam menilai kebolehgunaan aplikasi e-buku dari segi kebolehcapaian mereka yang membolehkan individu berkeperluan penglihatan mendapatkan manfaat yang sama seperti orang biasa. Namun, model penilaian kebolehgunaan e-buku semasa tidak menilai aplikasi e-buku mudah alih yang boleh dicapai bagi individu berkeperluan penglihatan kerana mereka tidak mempertimbangkan isu-isu aksesibiliti aplikasi-aplikasi ini dengan mencukupi. Kajian ini bertujuan untuk membangunkan satu model yang menilai kebolehgunaan aplikasi e-buku mudah alih yang mudah capai bagi individu berkeperluan penglihatan. Kajian literatur dan kaedah pengumpulan keperluan telah digunakan untuk menghasilkan faktor dan metrik penilaian kebolehgunaan, yang kemudiannya dibina sebagai satu model penilaian kebolehgunaan. Model ini telah disahkan oleh pakar bidang, dan datanya telah dianalisa menggunakan kaedah *Fuzzy Delphi*. Selain itu, model ini telah disemak untuk ketekalan, kemudahan penggunaan, kebolehfahaman, kebolehtentusahan dan kesan keseluruhan. Selain itu, satu siri ujian kebolehgunaan dalam talian dan sesi temu bual telah dijalankan dengan 12 individu berkeperluan penglihatan untuk mengesahkan keupayaan pengumpulan data model tersebut. Kaedah analisis deskriptif digunakan untuk menganalisis metrik objektif, dan analisis tematik deduktif telah dilakukan untuk menganalisis metrik subjektif daripada sesi temu bual. Kajian ini pada mulanya mencadangkan lima faktor: kepuasan, kebolehcapaian, kecekapan, keberkesanan dan kebolehpelajaran, dengan 35 metrik yang telah diperhalusi kepada 31 metrik selepas fasa pengesahan. Selain itu, model tersebut telah disahkan, dan dapatan menunjukkan keupayaannya untuk mengumpul data dan kebolehpercayaan model ini dalam konteks penggunaan sebenar. Model yang dicadangkan menyumbang kepada badan ilmu reka bentuk kebolehcapaian, kaedah penilaian dan reka bentuk interaksi manusia-komputer. Pembangun aplikasi mudah alih atau penyelidik kebolehgunaan boleh menggunakan model ini sebagai salah satu rujukan untuk membangunkan aplikasi e-buku mudah capai mudah alih yang sangat baik dan boleh digunakan untuk individu berkeperluan penglihatan. Dengan adanya aplikasi e-buku mudah alih yang boleh digunakan dan memuaskan, rutin pembelajaran dan membaca bagi individu berkeperluan penglihatan dapat menjadi lebih mudah diakses.

Kata Kunci: E-buku kebolehgunaan, Model Penilaian Kebolehgunaan, Metrik Kebolehgunaan untuk E-buku, E-buku untuk Individu berkeperluan penglihatan.

Abstract

Evaluation plays a critical role in assessing the usability of e-book applications in terms of their accessibility which allows the visually impaired to get the same benefits as ordinary people. However, current e-book usability evaluation models are not for evaluating accessible mobile e-book applications for the visually impaired as they did not sufficiently consider the accessibility issues of these applications. This study aims to develop a model that evaluates the usability of accessible mobile e-book applications for the visually impaired. Literature review and requirement-gathering methods were used to generate usability evaluation factors and metrics and later constructed as a usability evaluation model. This model was verified with 11 domain experts, and the data were analysed using the Fuzzy Delphi Method. Besides, the model was reviewed for consistency, ease of use, understandability, verifiability, and overall impression. Further, a series of online usability tests and interview sessions were conducted with 12 visually impaired participants to validate on data collection ability of the model. The descriptive analysis method was used to analyse objective metrics, and deductive thematic analysis was performed to analyse subjective metrics from interviews. This study initially proposed five evaluation factors: satisfaction, accessibility, efficiency, effectiveness, and learnability, with 35 metrics which were refined to 31 metrics after being verified. Besides, the model was validated, and the findings showed the ability to collect data and the reliability of this model in the actual context of use. The proposed model contributes to the knowledge of accessibility design, evaluation methods and human-computer interaction. Mobile application developers or usability researchers can use this model as one of the references for developing excellent and usable accessible mobile e-book applications for the visually impaired. By having a usable and satisfying accessible mobile e-book application, visually impaired learning and reading routines could be more accessible.

Keywords: Accessible e-book, Usability evaluation Model, Usability Metric for the e-book, E-book for Visually impaired.

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CHAPTER ONE
INTRODUCTION

1.1 Research Background

Usability is a quality characteristic that assesses the ease of using any software or application and it is a central concept in the evaluation (Park & Zahabi, 2021; Weichbroth, 2020). Mobile devices' usefulness has increased recently and led to performing more mobile device tasks (Al-Aidaroos & Mutalib, 2015). According to statistics (Statista, 2022), Smartphone usage will reach 78.05 percent by 2020. As of 2021, there were 6.23 billion smartphone subscribers, and the number is projected to rise to 7.7 billion by 2027. Consequently, mobile applications will become more popular and high-quality applications will be required (Harrison et al., 2013; Shitkova et al., 2015).

Several factors contribute to a high-quality mobile app. Among the most significant factor is usability, which faces an additional challenge with device mobility and their limitations (Flood et al., 2013; Harrison et al., 2013). Usability evaluation includes planning tasks, determining evaluation and data collection methods, and analysing the strategies (Zahra et al., 2017). Designers should explicitly study usability guidelines with evaluation methods in mobile applications due to their characteristics and difficulties in developing mobile applications (Shitkova et al., 2015). Accessibility is another essential aspect of application quality since users with different impairments or elderly individuals might have limited access to the user interface (UI) and content (Alajarmeh, 2021; Khan & Khusro, 2020; Vieritz et al., 2013).

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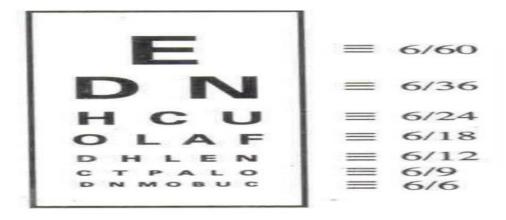
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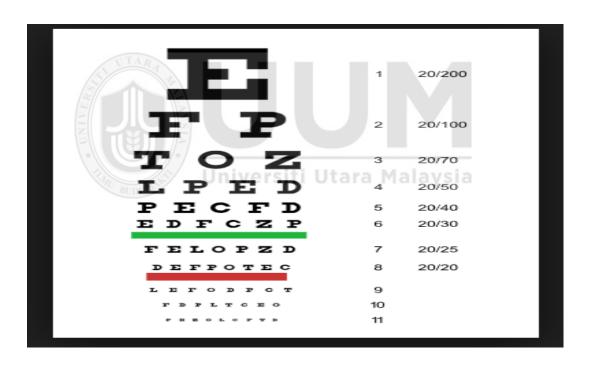
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Appendix A
Eye Test Charts

Distance Eye charts

Near eye test chart

A. Demographic Information:

Name: ……………………………………………………………………………	
Gender: …………………………….	Age: ………………………………………….
Matric NO.: ………………………….	NO.OKU: ………………………………
School: …………………………….	Degree Program: ……………………….
Mobile Phone Model: …………………………………….	Years of experience in using mobile phone: ……………………………………
Years of experience in using a computer: ………………………	Type of vision impairment: (Moderate, Severe, colour blind, or totally blind) Others: …………………………………… ……………………………………
Cause of Impairment: …………………………………………………………………….	

B.   Open-End Questions:

1.   Are you using any mobile applications? If yes:
a.   Can you list down the common mobile apps that you used in your daily life?
b.   How comfortable are you using these mobile applications?
c.   Can you list down the mobile apps that you use in your learning or in doing your assignment?
2.   How do you prepare for your online assignment?
3.   How do you answer your exam?
4.   What are the features that you normally used on your mobile phone? (Screen Reader, Voice Command, Text enlargement)
5.   What are the difficulties in using any mobile application?
6.   How is this application different from the rest of the applications?
7.   How do you read any print books usually?
8.   Please describe your level of experience with an e-book. If you have some experience:
a.   What device do you usually read an e-book in?
b.   What are the advantages of an e-book?
c.   What are the disadvantages or obstacles that you face when you read an e-book? …
9.   Are you using any e-book mobile applications? if yes,
a.   What is the name of the application?
b.   Have you heard of or downloaded a specific vision-impaired e-book application for people who cannot see or have low vision in their smartphone? If yes, what is the name of the application?
c.   How satisfied are you with these e-book application interfaces?

d.   Can you take an overview of the book content? If yes, how?
e.   Are you able to navigate and understand the flow of the e-book content easily?

10.   What is your opinion about e-book applications for blind or low-vision people? How is it different from a normal e-book?

11.   Which application is your preference (vision impaired/blind special e-book application or normal e-book application)?

12.   Do you think visually impaired people need special e-book applications or can use normal e-book apps?

13.   What do you think important aspect to be included in a mobile e-book application, especially for the blind user or low vision?

Other Comments you want to add:

………………………………………………………………………………………………………

………………………………………………………………………………………………………

………………

<div align="center">THANK YOU VERY MUCH</div>

Appendix C
Identification of Factors

Factor	Freq.	Source
Efficiency	27	Nielsen (1994), Goel (2018), ISO/9241-11 (1998), QUIM (2006), Dubey et al. (2012), Baharuddin (2013), Harrison (2013), Nathan (2017), Saleh (2017), (Jardina & Chaparro, 2012), El-Glaly et al., 2012), Jardina & Chaparro (2013), (Hussain et al., 2017), Shin et al. (2017), (Sulaiman & Mustafa, (2019). Lim et al. (2012), Baker-Eveleth & Stone (2015)
Effectiveness	22	ISO/9241-11 (1998), QUIM (2006), Dubey et al. (2012), Baharuddin (2013), Harrison (2013), Nathan (2017), Saleh (2017), Goel (2018), (Siegenthaler et al., 2010), (Jardina & Chaparro, 2012,2013, 2015), Shin et al. (2017), (Sulaiman & Mustafa, (2019), Baker-Eveleth & Stone (2015), Lim et al. (2012),
Satisfaction	21	Nielsen (1994), ISO/9241-11 (1998), QUIM (2006), Dubey et al. (2012), Baharuddin (2013), Harrison (2013), Nathan (2017), Saleh (2017), (Jardina & Chaparro, 2012), El-Glaly et al., 2012), Shin et al. (2017), Lim et al. (2012)
Learnability	13	Nielsen (1994), QUIM (2006), ISO 25023 (2016), Shamsudeen (2012), Baharuddin (2013), Harrison (2013), Nathan (2017), Saleh (2017), (Haslinda et al., 2014), Lim et al. (2012), Baker-Eveleth & Stone (2015), (Sulaiman & Mustafa, (2019)
Accessibility	10	QUIM (2006), ISO 25023 (2016), Nathan (2017), Jardina & Chaparro (2013), Lenzi & Leporini (2013), Maatta &Bonnici (2014), Mune & Agee (2014), Bartalesi & Lepoini (2015), Shine et al. (2017), (Sulaiman & Mustafa, (2019)
Error	9	Nielsen (1994), ISO 25023 (2016), Harrison (2013), Saleh (2017), Goel (2018), El-Glaly et al. (2012),
Cognitive Load	8	Harrison (2013), Saleh (2017), El-Glaly et al. (2012), (Jardina & Chaparro, 2012, 2013)
Navigation	7	(Siegenthaler et al., 2010), (Jardina & Chaparro, 2012, 2013, 2015), Lenzi & Leporini (2013), Mune & Agee (2015), Bartalesi & Leporini (2015)
Attractiveness	6	GQM (1994), mGQM (2012), Baharuddin (2013), Shamsudeen (2012), (Haslinda et al., 2014)
Memorability	6	Nielsen (1994), Harrison (2013), Saleh (2017)
Understandability	6	Shamsudeen (2012), Baharuddin (2013), Nathan (2017), (Haslinda et al., 2014)
Simplicity	5	GQM (1994), mGQM (2012), Baharuddin (2013), Saleh (2017), (Hussain et al., 2017)

features	4	GQM (1994), mGQM (2012), Maatta &Bonnici (2014) (Jardina & Chaparro, 2013, 2015), Mune & Agee (2015)
Safety	4	GQM (1994), mGQM (2012), QUIM (2006), Dubey et al. (2012)
UI aesthetic	2	IBaharuddin (2013), Goel (2018)
Operability	3	ISO 25023 (2016), Shamsudeen (2012), (Haslinda et al., 2014)
Accuracy	2	GQM (1994), mGQM (2012)
Time Taken	2	GQM (1994), mGQM (2012)
Usefulness	2	QUIM (2006), Baharuddin (2013)
Comrehensibility	2	Dubey et al. (2012), (Jardina & Chaparro, 2013)
Engagement	2	Jardina & Chaparro (2013), Baker-Eveleth & Stone (2015)
Productivity	1	QUIM (2006)
Internationality	1	QUIM (2006)
Trustfulness	1	QUIM (2006)
Recognizability	1	ISO 25023 (2016)
Intuitiveness	1	Baharuddin (2013)
Interraptibility	1	Saleh (2017)
Speed	1	Goel (2018)
Interactive GUI	1	Goel (2018)
Less storage consumption	1	Goel (2018)
User friendly	1	Goel (2018)
Battery Consumption	1	Goel (2018)
Performance	1	Goel (2018)
Platform dependency	1	Goel (2018)
Visibility	1	Hussain et al., 2017)
Enjoyability	1	Hussain et al., 2017)

Appendix D
Expert Request for Nomination Letter

Dear Prof/Dr/Sir/Madam,

My name is Munya Saleh Ba Matraf, a PhD research candidate in Information Technology (IT) specializing in Mobile Human-Computer Interaction (MHCI) at Universiti Utara Malaysia. Firstly, I would like to thank you for agreeing to be part of this study as an expert to verify a newly proposed model attempting to construct a usability evaluation model for an accessible mobile e-book applications interface for the visually impaired. The E-book is an alternative to the traditional reading methods for the visually impaired. However, the current mobile e-book applications are still not reaching a satisfactory level for users with vision disabilities. In addition, usability evaluation studies for these applications are not clear in terms of factors and metrics used in the evaluation. Therefore, this study aims to identify the factors and metrics involved in a usability evaluation to evaluate e-book applications for the visually impaired.

This study reviewed the related literature to derive the factors as well as reviewing the requirements of usable and accessible mobile applications and e-book applications to gather metrics for the proposed factors. The construction of the model with appropriate factors and metrics is to ensure that the model is satisfactory for evaluating the usability of mobile e-book applications for the visually impaired and able to detect specific issues as well as is aligned with the intention of the targeted users. The proposed model is aimed to be a guide for developers in evaluating the usability of the mobile e-book application intended for the visually impaired. It is essential to ensure that all new developers are aware of the importance of abiding by the evaluation factors during the design phase to guarantee that certain types of errors are avoided. Subsequently, it will help in reducing the effort and time needed to perform a development iteratively; implement-evaluate-improve.

The document contains a brief description of the proposed model together with a description of the identified factors and metrics, and a questionnaire. This questionnaire consists of three sections: an expert demographic, an instrument of measurement verification, and an expert general feedback form on the proposed model in terms of consistency, ease of use, understandability, and verifiability. Kindly review this model and fill up the questionnaire.

All the information will be used only for the research and feel free to give suggestions after the review. My supervisors can be contacted via their emails or phone numbers:

Assoc. Prof. Dr Nor Laily Binti Hashim	Assoc. Prof. Dr. Azham Hussain
Mobile: +6019-5110666	Mobile: +6012-6446977
laily@uum.edu.my	azham.h@uum.edu.my

Thank you for your time and co-operation.

Munya Saleh Ba Matraf

Mobile: 0060124973910, munyabamtarf@gmail.com

Appendix E
Expert Review Verification Form

A Usability Evaluation Model for   Accessible Mobile E-Book Applications for

The Visually Impaired (MUEBVI)

Section A: Expert Demographic

Expert Information	*Name:
	Specialization:
	Organization/Institute:
	Experience (Years):

SectionB: Instruments of Measurement Verification

This section will be verifying the consistency of flow between the selected metrics and factors in the proposed model. It contains a list of selected usability factors and metrics for the usability evaluation of accessible mobile e-book applications for the visually impaired. Kindly verify and provide suggestions where applicable.

The proposed Factors	Metrics	Strongly disagree……Strongly agree					Suggestions
		1	2	3	4	5	
Efficiency	Time taken to complete a task						
	The satisfaction of response time						
Effectiveness	Task success rate						
	The number of taps (touches) required to complete a task						
	Error rate						
	Satisfaction with the gesture interface provided						
	Satisfaction with the application's ability to support customizations and avoid modifications in user-defined configurations						
	Satisfaction with the ability to navigate book content by a table of content						
	Satisfaction with the ability to navigate the book						

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	content section by section forward and back					
	Satisfaction with the ability to navigate by a table of annotations (i.e., bookmarks, notes, highlights)					
	Satisfaction with the ability to navigate page forward and backwards (flipping)					
	Satisfaction with the ability to search book content					
	It is easy to navigate the e-book application interface					
	It is easy to access frequently used functions					
Learnability	Time on task					
	Easy-to-understand menus					
	Well-organized help information for new users.					
	Easy to learn to use the e-book application					
VI Accessibility	Satisfaction with alternative text provided for the interface element					
	Satisfaction with feedback provided for all actions/interactions					
	Satisfaction with the ability to disable feedback					
	Satisfaction with the ability to hear names of characters entered when taking notes					
	Satisfaction with text-to-speech (TTS) feature					
	Satisfaction with the ability to control the properties of TTS to user's preferences					
	Satisfaction with TTS Synchronized Highlighting					
	Satisfaction with the ability to change page brightness					
	Satisfaction with the ability to change colour contrast					
	Satisfaction with the ability to change text properties					

	Satisfaction with the ability to change the background colour						
	Satisfaction with the ability to enlarge text and images (e-book content)						
	Satisfaction with the ability to make voice command						
Satisfaction	Satisfaction with using an e-book as a reading tool						
	Satisfaction with the functions of the e-book						
	Satisfaction with the functions and tools of the e-book						
	Interface layout is perceivable and out of clutter						
	Overall Satisfaction						

Section C: Instruments of Model Verification

Instruction: This section is for verification of the model overall in terms of its applicability, originality, and understandability. There are five options: (5=Strongly Agree, 4= Agree, 3= Neutral, 2= Disagree, 1= Strongly Disagree) on each item, please tick on the scale accordingly.

No.	Consistency	1	2	3	4	5
1	Details provided in this model are consistent and according to the usability principles and guidelines					
2	The metrics provided are within usability measurement and consistent in the visually impaired context					
3	The metrics provided are related and in accordance with the factors in the model					
4	The model provided is appropriate for identifying the usability problem of the visually impaired on mobile e-book applications					

No.	Ease of Use	1	2	3	4	5
5	As a developer, this model is simple and easy to interpret and does not require mental effort to learn and use.					
6	Viewing all the measurements in the model reflects how easy to implement this model.					

No.		1	2	3	4	5
7	The model is easy to use and does not require much time.					
8	The model is flexible and allows feedback from users					

No.	Understandable	1	2	3	4	5
9	The model is readable and understandable from the initial to the final stage					
10	The process of measurement is defined clearly					

No.	Verifiable	1	2	3	4	5
11	Details provided allows fair assessment of the strength and weakness possess for accessible mobile e-book application interface of visually impaired					
12	The model can be applied for usability assessment of mobile e-book application interfaces for the visually impaired					

No.	Overall impression	1	2	3	4	5
13	The model is useful for mobile e-book applications in the visually impaired domain as the purpose is to meet their user needs and requirements					
14	The model is useful for academician research purposes and future amendments					
15	The model is useful for a developer and provides an easily understandable flow of content					
16	The model is useful for software development of the visually impaired industry in identifying usability issues for the special community					

17. Do you think that some other factors and metrics should be added to the model?

………………

If yes, please mentions them and kindly provide justification for your suggestion.

_____

18. Are there any of the factors and metrics proposed in the model that need to be removed?..............................

If yes, kindly list them and provide justification for your suggestion.

_____

19. Are the arrangement of the factors and metrics meeting the requirement as in the questionnaire?

_____

20. Any comments besides the above question?

_____

Thank you for your time and cooperation,

MUEBVI

- Efficiency
- Satisfaction
- Effectiveness
- Learnability
- Accessibility

Efficiency

Time taken to complete a task		
Satisfaction with response time		

Learnability

Time on task		
Easy to understand menus		
Well-organized help information for new users		
Easy to learn to use the e-book application		

Satisfaction

Satisfaction with using an e-book as a reading tool		
Satisfaction with the functions and tools of the e-book		
Satisfaction with using an e-book as a learning assisted tool		
The interface layout is perceivable and out of clutter		
Overall satisfaction		

Effectiveness

Task success rate		
The number of taps (touches) required to complete a task		
Error rate		
Satisfaction with gesture interface provided		
Satisfaction with the application's ability to support customizations and avoid modifications in user-defined		
Satisfaction with the ability to navigate book content by a table of content		
Satisfaction with the ability to navigate the book content by sections forward and back		
Satisfaction with the ability to navigate by a table of annotations		
Satisfaction with the ability to navigate page forward and backward (flipping)		
Satisfaction with the ability to search book content		
It is easy to navigate the e-book application interface		
It is easy to access frequently used functions		

Accessibility

Satisfaction with alternative text provided for interface element	
Satisfaction with feedback provided for all actions/interactions	
Satisfaction with the ability to disable feedback	
Satisfaction with the ability to hear names of characters entered when taking notes	
Satisfaction with text-to-speech (TTS) feature	
Satisfaction with the ability to control the properties of TTS to user's preferences	
Satisfaction with TTS Synchronized Highlighting	
Satisfaction with the ability to change page brightness	
Satisfaction with the ability to change color contrast	
Satisfaction with the ability to change text properties	
Satisfaction with the ability to change the background color	
Satisfaction with the ability to enlarge text and images (e-book content)	
Satisfaction with the ability to make voice command	

Legend

▢	Factor
▭	Metric

Red metrics are objective metrics

Appendix F
Informed Consent Form

TITLE OF STUDY
 A Usability Evaluation Model for   Accessible Mobile E-book Applications for the visually impaired

PRINCIPAL INVESTIGATOR
Munya Saleh Saeed Ba Matraf
School of Computing, Universiti Utara Malaysia
UUM, Sintok, Changloon, Kedah, Malaysia
0060124973910
munyabamatraf@gmail.com

PURPOSE OF STUDY

You are being asked to take part in a research study. Before you decide to participate in this study, it is important that you understand why the research is being done and what it will involve. Please read the following information carefully. Please ask the researcher if there is anything that is not clear or if you need more information.

The purpose of this study is to evaluate an accessible mobile e-book application for the visually impaired to validate a proposed usability evaluation model for mobile e-book applications which addressed the requirements of visually impaired users. The proposed model is aimed to be a guide for developers in evaluating the usability of the mobile e-book application intended for the visually impaired.

STUDY PROCEDURES

The session will be online/face-to-face, and it will be video recorded. The session will start with a short introduction followed by signing the informed consent form. A training session will be starting first to make you familiar with the interface of the mobile e-book application (Dolphin Easy Reader) followed by a usability test. In the usability test, we will request you to do some tasks and the time to complete the tasks and the number of touches as well will be recorded. Feel free to ask any questions during the test. After completing the tasks, we will have a break. After the break, a debriefing session will be started (interview questions).

The expected time for the session is varying from one user to another but is mostly around 3 hours with the break.

RISKS

There are no identifiable risks involved in your participation in this research study. You may decline to answer any or all questions and you may terminate your involvement at any time if you choose.

BENEFITS

The outcomes from this research will benefit researchers in addressing the current issues in mobile e-book applications and identifying user requirements for the design of the interface. This will help in developing a more accessible e-book application that will benefit you and the other visually impaired in terms of illuminating reading struggles and increasing knowledge.

CONFIDENTIALITY

The following procedures will be followed to keep your personal information confidential in this study: The data collected about you will be kept private to the extent allowed by law. To protect your privacy, your records will be kept under a code number rather than by name. Your records will be kept in locked files and only study staff will be allowed to look at them. Your name and any other fact that might point to you will not appear when the results of this study are presented or published.

Participant data will be kept confidential except in cases where the researcher is legally obligated to report specific incidents. These incidents include, but may not be limited to, incidents of abuse and suicide risk.

COMPENSATION

Your participation is voluntary. There will be no compensation for your participation.

CONTACT INFORMATION

If you have questions at any time about this study, or you experience adverse effects because of participating in this study, you may contact the researcher whose contact information is provided on the first page. If you have questions regarding your rights as a research participant, or if problems arise that you do not feel you can discuss with

the Primary Investigator, please contact UUM Institutional Review Board at 006049284771

VOLUNTARY PARTICIPATION

Your participation in this study is voluntary. It is up to you to decide whether to take part in this study. If you decide to take part in this study, you will be asked to sign a consent form. After you sign the consent form, you are still free to withdraw at any time and without giving a reason. Withdrawing from this study will not affect the relationship you have, if any, with the researcher. If you withdraw from the study before data collection is completed, your data will be returned to you or destroyed.

CONSENT

I have read and understood the provided information and have had the opportunity to ask questions. I understand that my participation is voluntary and that I am free to withdraw at any time, without giving a reason and without cost. I understand that I will be given a copy of this consent form. I voluntarily agree to take part in this study.

Participant's signature _____ Date _____

Investigator's signature _____ Date _____

Appendix G
Validation Form

Dear participant,

I am a student doing my PhD in Information Technology, at the School of Computing, Universiti Utara Malaysia. I am conducting a study on usability to evaluate an accessible mobile e-book application for the visually impaired to validate a proposed usability evaluation model for mobile e-book applications which addressed the requirements of visually impaired users. The proposed model is aimed to guide developers in evaluating the usability of the mobile e-book application intended for the visually impaired.

Your answer plays a significant role in the success of this study, and you are assured that such will be treated with the utmost confidentiality.

Kindly answer the questions on the next pages.

<h1 align="center">Section A: Participant's Profile</h1>

Details of application (filled by the researcher)	
Application Name:	Dolphin Easy Reader
Type of OS platform	☐Android ☐iOS
Date of assessment:	
Participant Code (initials):	
Participant email	

Details of Participant:

Please choose the appropriate answer:

Details of Participant (filled by the participant or the representative)	
Gender:	☐Male ☐Female
Nationality	
Age:	☐Less than 20 years ☐20-24 years ☐25-29 years ☐30-34 years ☐35-39 years ☐ 40 years and above
Current educational level	☐Bachelor's degree ☐Master's degree ☐Doctoral degree Other:…….
Mobile Application Experience	☐Never ☐Less Than One Year ☐1-5 Years

	☐6-10 Years ☐More Than 10 Years
Reading E-book Experience	☐Never ☐Less Than One Year ☐1-5 Years ☐6-10 Years ☐More Than 10 Years
Degree of Vision impairment	☐Moderate ☐Severe ☐Blindness Other:…………………………..
Type of vision impairment	☐Loss of Central Vision ☐Loss of Peripheral (Side) Vision ☐Blurred Vision ☐Generalized Haze ☐Extreme Light Sensitivity Others:………………………...
Cause of vision impairment	☐Glaucoma ☐Cataracts ☐Trachoma ☐Diabetic retinopathy ☐Eye injuries ☐Inherited conditions ☐Infections ☐Retinal detachment ☐Age-related macular degeneration Others: ………………………………………….
Assistive technology: **Any device, software, or tool that helps people with disabilities learn, communicate, or function better. Can be as high-tech as a computer. Or as low-tech as a walking stick. Often called AT.**	
Assistive technology used	☐Screen readers such as JAWS, TalkBack and ☐VoiceOver

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	☐Enlargement or magnification tools
	☐Voice command (recognition)
	☐Text to Speech technology
	☐Literacy in Software and Hardware
	☐Peripheral's devices
	Other: …………………………………………

Next page

<div align="center">**Section B: Task Sheet**</div>

List of Tasks

This study is important to address the current usability issues in e-book applications from the visually impaired point of view. Therefore, I would like to ask you to perform some tasks as listed below and after completing the tasks, you will be asked some questions in the interview session. The study uses Dolphin Easy Reader as one of the recommended e-book applications for the visually impaired and the book title is (Popular Technology, or Professions and Trades. Vol.2 (of 2) by Edward Hazen) which can be downloaded for free from Project Gutenberg and available in EPUB format. For Arabic participants, the title of the book is 48 Questions about Fasting. Author: Muhammad Al-Uthaymeen.

Before the tasks, the book title will be downloaded and opened. Blind and Severely visually impaired may require the activation of screen readers. The user will have 15 minutes to explore the application interface before starting the test.

Note: If you face any difficulties in performing the task, first: look for the help menu. If you still do not understand, feel free to ask for help.

1. Find the table of content (TOC)

2. Search for "THE COPPER" heading

3. Move between different headings levels forward and backward

4. Make 2 bookmarks

5. Look for the bookmarks that you made

6. Activate Text-to-Speech Feature (TTS)

7. Change the TTS settings to your preference

8. Change the text appearance to your preference (i.e., font (type, size, colour), line spacing, etc.)

9. Look for "HELP FOR EASYREADER"

Section C: Interview Questions

1. To what extent are you satisfied with the functions available in this application to support reading books? If you are not satisfied, why?
2. To what extent are you satisfied with the time taken to respond during the test?
3. Would you like to be able to add annotations to your e-book applications? If so, why?
4. What are the navigation functions that this application effectively supports? Table of content? Navigation by sections forward and backwards? Navigation by a table of annotations? Navigation by search? The ability to continue reading from the last page you read when reopening the application?
5. Does the application support an adequate gesture interface, if not, what is missing?
6. Would you prefer that the system keep the settings for example the setting of TTS, text appearance, and so on? If not, why?
7. What are the functions that make this application accessible for you (for example by letting read the book content with ease)? Change properties? Change background colour? Change brightness? Enlarge text and images? High contrast? Make voice command?
8. Is the text-to-speech feature necessary for you to be able to read the e-book? Why?
9. When the text-to-speech feature is set to active, are you able to follow what is spoken better after you have adjusted the text-to-speech setting?
10. Is highlighting what is spoken by text-to-speech feature useful or you can follow the reading text without it? If the highlight of the text is not a useful feature, could you explain why?
11. When using this e-book application, what is making the screen reader inefficient? Missing alternative text? Unable to hear the name of entered characters? Absent of feedback? **(For participants who use a screen reader)** *
12. Would you like to disable feedback once you become familiar with the application? **(For participants who use a screen reader)** *
13. Is there any problem with the layout of the e-book interface? If there are problems with the e-book layout, could you elaborate on them?
14. How easy is it for you to learn the application? If not easy, why?
15. Do you understand the menus? If not, what is the problem?
16. Is the help information particularly helpful? If not, why?
17. Could you share any problems or difficulties that you faced when using this application?
18. What improvements would you recommend for this application?
19. What are the likes and dislikes of the application?
20. Is there additional feedback that would you like to make?

Appendix H
New Metrics List

The proposed Factors		Metrics
Efficiency	EFCM1	Time taken to complete a task
	EFCM2	The number of taps (touches) required to complete a task
Effectiveness	EFvM1	Task success rate
	EFvM2	I can search book content
	EFvM3	The gesture interface provided is adequate
	EFvM4	I can navigate book content using a table of content
	EFvM5	I can navigate the book content section by section forward and back
	EFvM6	I can navigate by a table of annotations (i.e., bookmarks, notes, highlights)
	EFvM7	I can continue reading the e-book from the page I last finished reading without putting a bookmark
	EFvM8	I can make annotations
	EFvM9	The application prevents system modifications in user-defined
Learnability	LRNM1	Easy to learn to use the e-book application
	LRNM2	Easy-to-understand menus
	LRNM3	Well-organized help information for new users
VI Accessibility	VIACCM1	I can change text properties
	VIACCM2	I can change the background colour
	VIACCM3	I can change the page brightness
	VIACCM4	I can enlarge text and images (e-book content)
	VIACCM5	I can make a voice command
	VIACCM6	It has Text-to-speech (TTS) feature that is provided for assistance when needed
	VIACCM7	I can control the properties of TTS to the user's preferences
	VIACCM8	An alternative text is provided for an interface element such as icons and a search field
	VIACCM9	I can hear the names of characters entered when taking notes
	VIACCM10	The interface layout is out of the clutter
	VIACCM11	I can change colour contrast
	VIACCM12	Feedback is adequately provided for all actions/interactions
	VIACCM13	I can disable feedback
	VIACCM14	TTS feature provided Synchronized Highlighting
Satisfaction	SATM1	I am satisfied with its functions
	SATM2	I am satisfied using it as a reading tool
	SATM3	I am satisfied with its response time