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Article

Factors Influencing Developers' Acceptance of Native Development Environments: An Expansion of the Technology Acceptance Model

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Online-Appendix zu

„Factors Influencing Developers' Acceptance of Native Development Environments: An Expansion of the Technology Acceptance Model“

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Appendix

Appendix A: Literature Review

A1: TAM Studies

Following table provides a summary of the four TAM studies used for this analysis.

Author	Contribution	Citations
(Davis 1989)	Introduction of TAM and respective constructs: usage behavior, attitude, intention to use, perceived usefulness and perceived ease of use.	51222*
(Davis et al. 1989)	Revised version of TAM. Validated previous constructs, but excluded the construct attitude.	26092*
(Venkatesh and Davis 2000)	Identification of external constructs of perceived usefulness: subjective norm, image, job relevance, output quality and result demonstrability.	18999*
(Venkatesh 2000)	Identification of external constructs of perceived ease of use: self-efficacy, perception of external control, anxiety, playfulness, perceived enjoyment and objective usability.	6211*

Note: *Based on Google Scholar

Table 4: Relevant TAM Studies

A2: Studies on Third-party Developers

Following table provides a summary of the six studies on factors influencing third-party developers.

Author	Contribution
(Hertel et al. 2003)	"Motivation of software developers in Open Source projects: an Internet-based survey of contributors to the Linux kernel"
(Hilkert et al. 2010)	"Revealing how the different motivations of social application developers are interrelated and how these motivations influence application developers' effort intensity on the platform."
(Huy and Van Thanh 2012)	"The goal of this paper is to contribute to the selection of suitable mobile app paradigms in their development. Five mobile paradigms namely native apps, platform-based apps, mobile widgets, Web apps and HTML mobile apps are identified and described. They are then evaluated from developer viewpoint based on a set of selected criteria."
(Koch and Kerschbaum 2014)	"This paper evaluates why innovators publish applications for smartphone operating systems, and which factors influence their choice between the two most common platforms, Android and Apple iOS, and leading them to join this respective ecosystem."
(Lee et al. 2016)	"This study explores the key activation factors of the mobile application development platform through a comparative analysis of Apple App Store."
(Steglich et al. 2019)	"This study aims to complement earlies studies by describing new social factors that influence developers to work in a MSECO."

Table 5: Studies on Third-party Developers

A3: Relevant Literature Identifying External Constructs

Following table provides an overview of external constructs introduced by Venkatesh and Davis (2000) and Venkatesh (2000) and the corresponding proof of relevance in this study's context.

External Construct	Introduced by	Proof of Relevance
Subjective norm	(Venkatesh and Davis 2000)	(Hertel et al. 2003)
Image	(Venkatesh and Davis 2000)	(Hilkert et al. 2010; Koch and Kerschbaum 2014; Steglich et al. 2019)
Job relevance	(Venkatesh and Davis 2000)	(Hilkert et al. 2010; Koch and Kerschbaum 2014; Lee et al. 2016)
Output quality	(Venkatesh and Davis 2000)	(Huy and Van Thanh 2012; Steglich et al. 2019)
Result demonstrability*	(Venkatesh and Davis 2000)	-
Developer community	-	(Koch and Kerschbaum 2014; Steglich et al. 2019)
Training	-	(Hilkert et al. 2010; Lee et al. 2016; Steglich et al. 2019)
Self-efficacy	(Venkatesh 2000)	(Hertel et al. 2003)
Perception of external control	(Venkatesh 2000)	(Koch and Kerschbaum 2014; Lee et al. 2016)
Anxiety*	(Venkatesh 2000)	-
Playfulness*	(Venkatesh 2000)	-
Perceived enjoyment	(Venkatesh 2000)	(Koch and Kerschbaum 2014; Steglich et al. 2019)
Objective usability*	(Venkatesh 2000)	-

Note: *excluded for reasons of relevance

Table 6: Analyzed External Constructs

Appendix B: Online Questionnaire

B1: The Questionnaire

In the following the detailed questionnaire is displayed. It was created using SoSci Survey.

0% completed

Welcome to this survey!

Dear participant,

my name is Nadja Ganter and within the scope of my bachelor's thesis, I want to invite you to participate in my survey regarding mobile app development on Native Development Environments (NDEs). NDEs refer to the development environments provided by the operating system provider itself. Thereby, this study primarily focuses on the NDEs of iOS and Android (e.g.: Android Studio and Xcode). This survey is intended for developers who have developed or have participated in the development of mobile apps on NDEs. Based on this investigation the main factors influencing developers to adopt to NDEs will be identified.

Answering the survey will take approximately 5 minutes and your participation is completely voluntary. In the survey, I will deliberately ask some questions that sound similar. This is carried out for methodological reasons. Please take your time to answer all questions thoroughly.

All collected answers will be processed confidentially. The results of the study will only be used for academic purposes and examined in an anonymous and aggregated manner so that it is not possible to identify individual participants.

If you have any questions, please feel free to contact me via e-mail: nadja.ganter@student.reutlingen-university.de

Thank you very much for your time and support of my study.

Best regards,

Nadja Ganter

1. To which extent do you use a NDE to develop mobile apps?

NDE = Native Development Environment (such as Android Studio or Xcode)

- ◯ I use a NDE only if its unavoidable
- ◯ I rarly use a NDE
- ◯ I sometimes use a NDE
- ◯ I mainly use a NDE
- ◯ I exclusively use a NDE

2. On which NDE have you developed applications

- ◯ NDE provided by Android
- ◯ NDE provided by iOS
- ◯ Both
  (In case you choose this option, please relate the following questions to the NDE you use more frequently)
- ◯ Others

3. Please check a box for each statement to show how much you agree or disagree with it.

	strongly disagree 1	2	3	4	strongly agree 5
I usually develop mobile apps on the NDE	◯	◯	◯	◯	◯
The NDE improves my app development performance	◯	◯	◯	◯	◯
Using the NDE increases my productivity	◯	◯	◯	◯	◯
The NDE is useful for me	◯	◯	◯	◯	◯
I find it easy to use the NDE	◯	◯	◯	◯	◯
Learning how to use the NDE was easy for me	◯	◯	◯	◯	◯
I intent to be a heavy user of the NDE	◯	◯	◯	◯	◯
I aim to use the NDE often	◯	◯	◯	◯	◯
It is easy to become skillful at the NDE	◯	◯	◯	◯	◯

4. Please check a box for each statement to show how much you agree or disgaree with it
NDE=Native Development Environment

	strongly disagree 1	2	3	4	strongly agree 5
Through the NDE I improved my developing skills	◯	◯	◯	◯	◯
The NDE provides training in app development	◯	◯	◯	◯	◯
People I learn from, think I should use the NDE	◯	◯	◯	◯	◯
My peers support the use of the NDE	◯	◯	◯	◯	◯
Through developing on the NDE I signal skills and competences	◯	◯	◯	◯	◯
I enhance my reputation through developing apps on the NDE	◯	◯	◯	◯	◯
The usage of the NDE is part of my job	◯	◯	◯	◯	◯
The monetary reward through app development on the NDE is important for me	◯	◯	◯	◯	◯
The NDE enables me to develop good apps	◯	◯	◯	◯	◯
I rate my results from the NDE to be excellent	◯	◯	◯	◯	◯
A community of other developers using the same NDE is valuable for me	◯	◯	◯	◯	◯
My social environment supports the use of NDEs	◯	◯	◯	◯	◯
People using the NDE receive good reputation	◯	◯	◯	◯	◯
In my job the NDE is relevant	◯	◯	◯	◯	◯
The quality of the app I get from the NDE is high	◯	◯	◯	◯	◯

5. Please check a box for each statement to show how much you agree or disagree with it.
NDE=Native Development Environment

	strongly disagree 1	2	3	4	strongly agree 5
Learning facilities (tutorials, learning guides,...) of the NDE help me getting better in app development	◯	◯	◯	◯	◯
I enjoy being part of the developer community	◯	◯	◯	◯	◯
I benefit from other developers using the same NDE	◯	◯	◯	◯	◯
I am able to use the NDE, even if there is no one telling me how to use it	◯	◯	◯	◯	◯
I have the necessary skills for using the NDE	◯	◯	◯	◯	◯
For me it is intuitive to use the NDE	◯	◯	◯	◯	◯
I have fun developing apps on the NDE	◯	◯	◯	◯	◯
The actual process of using the NDE is enjoyable	◯	◯	◯	◯	◯
I enjoy developing apps on the NDE	◯	◯	◯	◯	◯

On the NDE, ...	strongly disagree 1	2	3	4	strongly agree 5
sufficient platform-specific SDKs are provided	◯	◯	◯	◯	◯
rich APIs are provided	◯	◯	◯	◯	◯
sufficient documentation is provided	◯	◯	◯	◯	◯
I have the resources necessary to use the NDE	◯	◯	◯	◯	◯

6. How many years of experience do you have in developing mobile apps on the NDE?

I have ☐ years of experience.

7. What is your gender?

- ◯ female
- ◯ male
- ◯ other

8. How old are you?

I am ☐ years old.

9. Which is the country, you're currently living?

Country: ☐

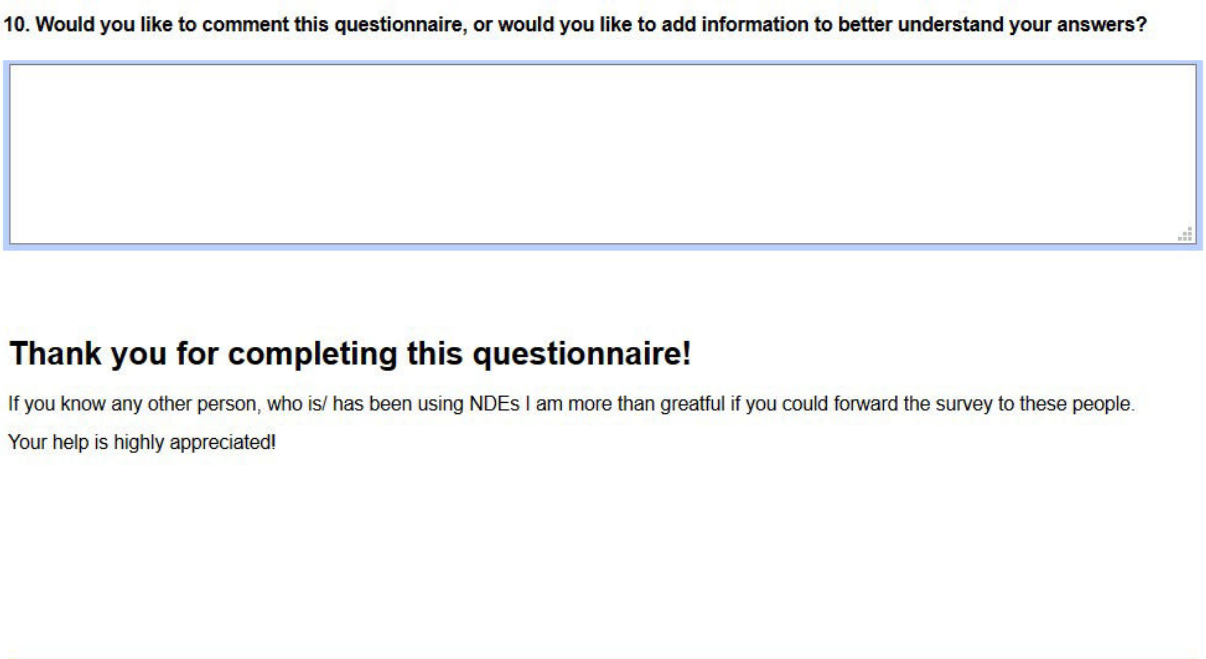

Figure 4: Online Questionaire

B2: Distribution Channels

The questionnaire was distributed using the following distribution channels, in a time period from 30.03.2020 to 19.04.2020.

Platform	Name	Reach
Facebook	Android Developers, iOS Developer , WEB Developers , Flutter Developers	18200
Facebook	Ios Developers	23900
Facebook	IoS & Android App Developers	14800
Facebook	#Android-Stuido #xcode # native # mobile	1900
Facebook	Apple Developer Academy Worldwide Community	680
Facebook	Android Developers	250400
Facebook	Apple Developers	17100
Facebook	Freelance iOS App Developer	9000
Facebook	Android Apps Development	11700
Facebook	Mobile App Development	25100
Reddit	Apple iOS	113000
Reddit	Android	2100000
Reddit	Developing Android Apps	137000
Linkedin	iOS Developers Group	102038
Linkedin	iOS App Developers Worldwide	18456
Linkedin	Google Android	197967
Linkedin	Hybrid and native mobile app development	1212
Linkedin	Mobile App Development: iOS, Android, Windows Developers	6220
Linkedin	Developers - Android, iOS developer , Blockchain, Ethereum, Java, Ruby, .net, php, django, etc	213252
Twitter	Android/ iOS Mobile App Development	1100
Stackoverflow	#MobileAppDevelopment #NativeDevelopmentEnvironments	
Informatic Institutes	The University of Edinburgh, Information School University of Washington, UCI Havana, University of Leicester, University of Bergen, University of Zurich, Indiana University Bloomington, Kyoto University, Belarusian State University, Donald Bren School, University of Oslo, University of Amsterdam, Vilnius University, TU Wien, Northeastern University, Nagoya University, Ionian University, University of Lowa, KIT Karlsruhe, Universität Freiburg, Universität Leipzig, Universität Stuttgart, Universität Heidelberg, Universität Lübeck, Universität Dresden, Göthe Uni Frankfurt, Universität Paderborn, LMU München, THU Ulm, Infai Leipzig, TU Braunschweig, TU Ilmenau, HHU Düsseldorf, SIC Saarland, Eberhard Karl Tübingen, Uni Würzburg, Hochschule Ruhr-West, TU Clausthal, Ruhr-Universität Bochum, Uni Jena, Universität Bonn, Universität der Bundeswehr München, RWTH Aachen	
App Development companies	Tapptitude, Appnovation, Consagous, Ripenapps, Openxcell, Intellectsoft, Rubygarage, Digiteum, Algoworks, Techaheadcorp, Zco, Appinventiv, Itcraftapps, Stfalcon, Devtechnosys, Cheesecakelabs, Quytech, Mindsea, Smartym, Hyperlinkinfosystem, Applify, Thinksys, Scnsoft, Sidebench, Halcyonmobile, Nickelfox, Anoda, Bluewhaleapps,Rretrocube, Infimum, 648group, Mutualmobile, Clover.studio, Appventurez, Impigertech, Nimbleappgenie, Mobulous, Coppermobile, Celadonsoft, Kindgeek, Monkeytech, Xmartlabs, Cruxlab, Steelkiwi	

Table 7: Distribution Channels for the Online Questionnaire

Appendix C: Data Analysis Results by SmartPLS

C1: Research Model as illustrated in SmartPLS

In the following, the research model as it is displayed by SmartPLS, is illustrated.

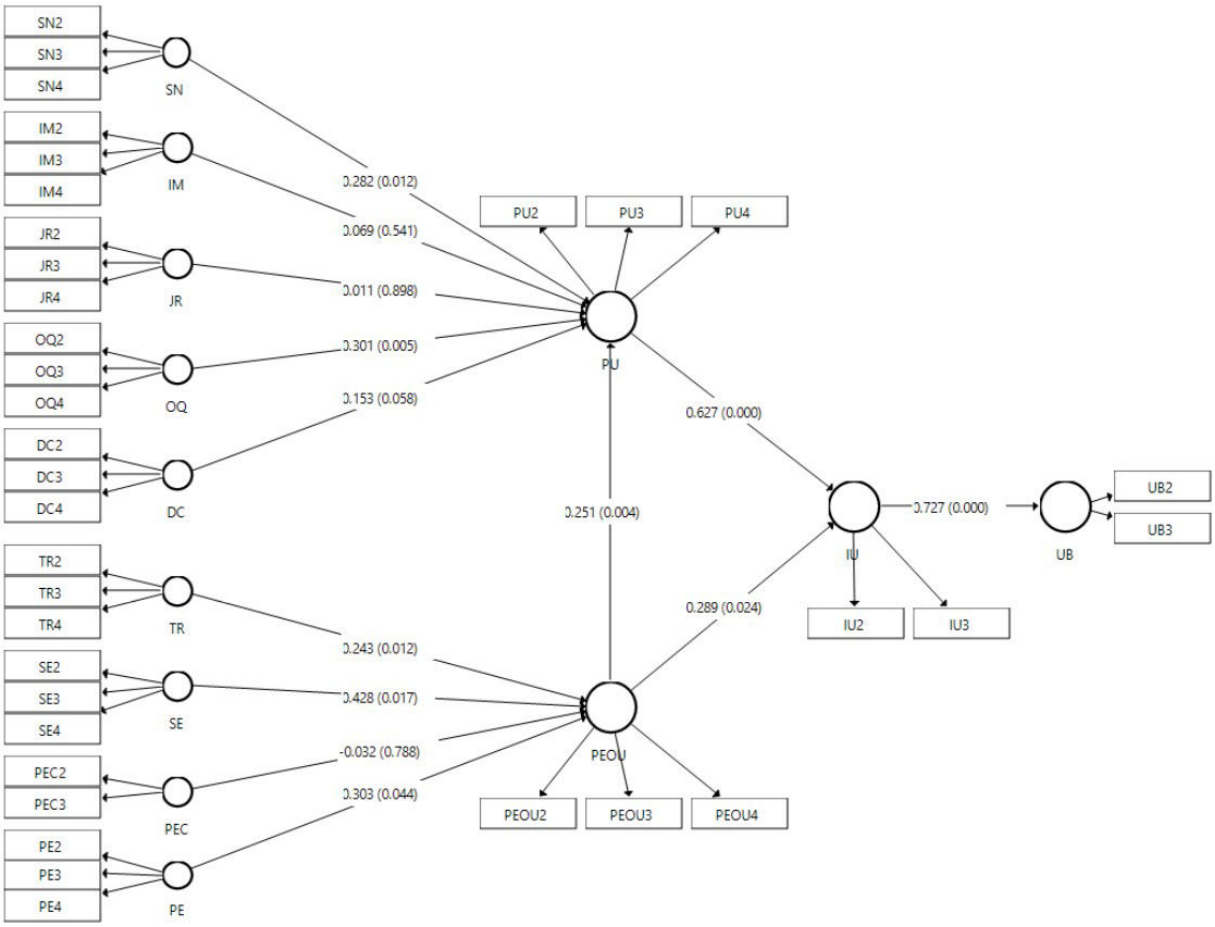

Figure 5: Research Model in SmartPLS

C2: Multigroup Analysis

In the following the parametric test results conducting a MGA is displayed.

	Path Coefficients-diff (Android - iOS)	t-Value(|Android vs iOS|)	p-Value (Android vs iOS)
DC -> PU	-0,045	0,308	0,759
IM -> PU	-0,125	0,759	0,449
IU -> UB	0,089	0,580	0,563
JR -> PU	-0,011	0,079	0,937
OQ -> PU	0,047	0,262	0,793
PE -> PEOU	0,260	1,469	0,145
PEC -> PEOU	-0,021	0,089	0,930
PEOU -> IU	0,119	0,693	0,490
PEOU -> PU	-0,104	0,654	0,515
PU -> IU	0,021	0,158	0,875
SE -> PEOU	0,124	0,588	0,558
SN -> PU	0,249	1,349	0,180
TR -> PEOU	-0,234	1,373	0,172

Table 8: Multigroup Analysis

C3: Discriminant Validity

Following Table 9 and Table 10 highlight the discriminant validity tests' result.

	DC	IM	IU	JR	OQ	PE	PEC	PEOU	PU	SE	SN	TR	UB
DC	0,92												
IM	0,56	0,89											
IU	0,56	0,56	0,76										
JR	0,46	0,68	0,63	0,84									
OQ	0,56	0,72	0,65	0,68	0,90								
PE	0,65	0,63	0,76	0,63	0,68	0,87							
PEC	0,64	0,49	0,66	0,42	0,59	0,70	0,93						
PEOU	0,55	0,59	0,74	0,59	0,59	0,79	0,64	0,88					
PU	0,66	0,72	0,83	0,66	0,78	0,83	0,69	0,72	0,86				
SE	0,49	0,59	0,74	0,61	0,70	0,78	0,75	0,80	0,74	0,82			
SN	0,55	0,69	0,60	0,65	0,66	0,62	0,51	0,57	0,76	0,63	0,90		
TR	0,61	0,67	0,57	0,58	0,66	0,70	0,56	0,71	0,69	0,64	0,71	0,91	
UB	0,43	0,55	0,73	0,69	0,63	0,68	0,35	0,60	0,75	0,52	0,67	0,64	0,80

Note: Diagonal elements are the square roots of the AVE

Table 9: Fornell-Larcker Criterion

	DC	IM	IU	JR	OQ	PE	PEC	PEOU	PU	SE	SN	TR	UB
DC													
IM	0,56												
IU	0,56	0,56											
JR	0,46	0,69	0,63										
OQ	0,55	0,73	0,65	0,68									
PE	0,65	0,63	0,76	0,62	0,69								
PEC	0,64	0,49	0,66	0,41	0,59	0,70							
PEOU	0,55	0,59	0,74	0,59	0,59	0,79	0,64						
PU	0,66	0,72	0,83	0,66	0,78	0,83	0,69	0,71					
SE	0,50	0,60	0,74	0,61	0,71	0,79	0,76	0,79	0,74				
SN	0,55	0,69	0,60	0,66	0,66	0,62	0,51	0,57	0,76	0,63			
TR	0,61	0,66	0,57	0,58	0,66	0,71	0,56	0,71	0,68	0,64	0,71		
UB	0,43	0,58	0,73	0,72	0,64	0,70	0,35	0,61	0,76	0,53	0,69	0,65	

Table 10: Heterotrait-Monotrait Ratio