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PEMBANGUNAN INSTRUMEN UNTUK MENGUKUR KEBIASAAN DAN KESUKARAN PENGGUNA DALAM MENGGUNAKAN SKRIN SENTUH KAWALAN BERPUSAT KENDERAAN TENAGA BARU (NEV)

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Abstrak

Artikel ini bertujuan meneroka tahap kebiasaan dan kesukaran pengguna dalam menggunakan skrin sentuh kawalan berpusat yang berada dalam Kenderaan Tenaga Baharu (NEV) dan menilai persepsi pengguna terhadap kebolehgunaan dan kemudahan untuk mengguna skrin sentuh kawalan berpusat tersebut. Dengan mengambil kira ketidakcukupan alat pengukuran sedia ada untuk merangkumi sepenuhnya kompleksiti antara muka pengguna NEV dan kepelbagaian pengguna, maka sebuah instrumen penyelidikan baru telah dibangunkan. Instrumen ini berdasarkan Teori Beban Kognitif dan Teori Kognitif Sosial, yang merangkumi konstruk berkaitan Kesukaran seperti Kompleksiti Sistem, Kepelbagaian Pengguna, Teknologi Baru, Faktor-faktor Emosi dan Psikologi, serta konstruk kebiasaan pengguna seperti Konsistensi, Kemampuan, Konvensional, Kajian Pengguna, dan Pengendalian Ralat. Melalui satu kajian rintis yang ditadbir ke atas pengguna kereta Tesla di Chengdu, China, data dianalisis menggunakan perisian SPSS (versi 27) dan SmartPLS (versi 4) untuk menentukan kesahan dan kebolehpercayaan instrumen penyelidikan. Dapatan menunjukkan bahawa pekali Alpha Cronbach menunjukkan konsistensi dalaman yang baik merentasi konstruk, berkisar dari 0.72 hingga 0.87, kecuali untuk konstruk "Kepelbagaian Pengguna", yang sedikit di bawah ambang batas yang diterima iaitu pada 0.68 berbanding dengan 0.7. Kajian mendapati bahawa tahap kebiasaan dan kesukaran pengguna secara signifikan mempengaruhi penerimaan pengguna terhadap skrin sentuh kawalan berpusat, ini menunjukkan bahawa terdapat keperluan kepada pihak pereka untuk mempertimbang faktor-faktor ini dalam proses pembangunan antara muka pengguna bagi sistem tersebut untuk diaplikasikan dalam Kenderaan Tenaga Baharu (NEV). Dapatan kajian juga menunjukkan bahawa ia tidak hanya menekankan kepentingan mempertimbangkan kebiasaan dan kesukaran pengguna dalam reka bentuk antara muka skrin sentuh kawalan berpusat kenderaan tenaga baharu (NEV), tetapi juga menyediakan panduan penting dan alat penilaian untuk reka bentuk antara muka pengguna pada masa hadapan.

Kata Kunci: Antara Muka Pengguna, Reka Bentuk Tanpa Sedar, Skrin Sentuh Kawalan Berpusat, Kenderaan Tenaga Baharu (NEV), Kebolehpercayaan dan Kesahan.

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DEVELOPING INSTRUMENT TO MEASURE FAMILIARITY AND DIFFICULTY TO USE CENTRAL CONTROL TOUCHSCREENS OF NEW ENERGY VEHICLES (NEV)

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Abstract

This paper aims to explore user familiarity and difficulty in using central control touchscreens in New Energy Vehicles (NEVs) and assess the impact of these factors on users' perceived usefulness and ease of use. Given the inadequacy of existing measurement tools to fully cover the complexities of NEV user interfaces and user diversity, we developed a new research instrument. This instrument is based on Cognitive Load Theory and Social Cognitive Theory, covering difficulty-related constructs such as System Complexity, User Diversity, Emerging Technologies, Emotional and Psychological Factors, as well as familiarity-related constructs including Consistency, Affordance, Conventions, User Research, and Error Handling. Through a pilot study conducted among Tesla car users in Chengdu, China, data were analyzed using SPSS (version 27) and SmartPLS (version 4) software to determine the reliability and validity of the research instrument. Results of the Cronbach's alpha coefficients showed good internal consistency across constructs, ranging from 0.72 to 0.87, except for the "User Diversity" construct, which slightly fell below the acceptable threshold of 0.7 at 0.68. The study found that user familiarity and difficulty significantly influence the acceptance of central control touchscreens, indicating the need for designers to consider these factors in the development of NEV user interfaces. The results not only emphasize the importance of considering user familiarity and difficulty in NEV design but also provide crucial guidelines and assessment tools for future user interface design.

Keywords: *Unconscious Design, Central Control Touchscreens, New Energy Vehicles (NEV), User Interface, Reliability and Validity*

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1.0 Introduction

The advancement of New Energy Vehicles (NEV), including electric and hybrid cars, marks a significant shift in automotive technology towards environmental sustainability. At the core of this technological evolution is the development of user interfaces, particularly central control touchscreens. As highlighted by Mutabazi (2023), Tesla's approach in creating a comprehensive ecosystem around its products, akin to Apple's strategy with the iPhone, offers a unique perspective on the integration of user interfaces in NEVs, including touchscreens. These touchscreens are essential for facilitating communication between the driver and the vehicle, conveying crucial information about vehicle performance and status, and enabling control over various functions.

Contrasting views on touchscreen usability in vehicles have emerged, as noted in discussions on Hacker News (2019), where some users express a preference for tactile analog controls over digital touchscreens. This debate is critical for understanding user interaction with these systems. This study, therefore, focuses on examining the role of user familiarity and the difficulties encountered in interacting with these touchscreens and their impact on perceived usefulness and ease of use. Special emphasis is placed on the concept of unconscious design, a design philosophy that subtly integrates intuitive elements into the interface to enhance user interaction and experience. Real-world insights into the usability and design challenges of Tesla's touchscreens, particularly in the Tesla Model 3, are shared by users in a Reddit thread (2022), providing valuable context for this research.

This research aims to clarify its objectives and methodologies by focusing on developing and validating an instrument to measure user familiarity and difficulty with central control touchscreens in NEVs. Utilizing this instrument, the study further explores the correlation between these factors and user acceptance of such touchscreens, with the Tesla Model 3 serving as a case study. The findings are anticipated to make significant contributions to the field of interactive interface design in NEVs, prioritizing user safety and experience (Mutabazi, 2023; Hacker News, 2019; Reddit, 2022).

2.0 Literature Review

The incorporation of central control touchscreens in New Energy Vehicles (NEVs) marks a significant evolution in the interface between driver and vehicle. This chapter critically examines the theoretical underpinnings and research findings pertaining to the variables of difficulty and familiarity that shape user interaction with these systems.

2.1 Difficulty Variable

The 'Difficulty' variable captures the challenges users face when interacting with NEVs' central control touchscreens. The constructs of difficulty are considered through the following lenses:

Table 1: Difficulty: second-order

Variable	Variable’s Constructs	Question Code
Difficulty	System Complexity	DI11
		DI12
		DI13
	User Diversity	DI21
		DI22
		DI23
	Emerging Technologies	DI31
		DI32
		DI33
	Emotional and Psychological Factors	DI41
		DI42
		DI43

2.1.1 System Complexity

System complexity affects user performance and cognitive load. This construct has been explored by Franke, Görges, & Arend (2019), who looked at energy interface design in electric vehicles with an emphasis on users' perceptual limits and rationality constraints.

2.1.2 User Diversity

The diversity among users in terms of their ability to interact with technology is a critical factor in interface design. Goodman-Deane, Ward, & Clarkson (2020) shed light on the necessity of accounting for this diversity in design practices.

2.1.3 Emerging Technologies

Emerging technologies influence how users engage with interface systems. Lee, Kozar, & Larsen (2019) addressed the implications of these technologies for user interaction, stressing both the potential and challenges they present.

2.1.4 Emotional and Psychological Factors

Users' emotional and psychological responses to technology are addressed by Beaudry & Pinsonneault (2010), who explored how these factors can affect the acceptance and use of new systems.

2.2 Cognitive Load Theory (CLT)

Cognitive Load Theory, as described by Sweller, Ayres, & Kalyuga (2011), offers insight into how the cognitive demands of an interface impact user interaction, informing the design of more effective and user-friendly systems.

2.3 Familiarity Variable

Familiarity with an interface is a key determinant of its usability.

Table 2: Familiarity: second-order

Variable	Variable's Constructs	Question Code
Familiarity	Consistency	FA11
		FA12
		FA13
	Affordance	FA21
		FA22
		FA23
	Conventions	FA31
		FA32
		FA33
	User research	FA41
		FA42
		FA43
	Error handling	FA51
		FA52
		FA53

2.3.1 Consistency

Consistency in interface design aids user familiarity and reduces difficulty, as noted by Nielsen (1994).

2.3.2 Affordance

Affordance, as discussed by Norman (1999), refers to design elements that allow users to intuitively discern how to use an interface.

2.3.3 Conventions

Conventions in design, highlighted by Lidwell, Holden, & Butler (2003), provide users with a sense of familiarity, leveraging established patterns and standards.

2.3.4 User Research

The role of user research in design is emphasized by Rubin & Chisnell (2008), underlining the importance of understanding user needs and preferences.

2.3.5 Error Handling

Effective error handling mechanisms are critical for a positive user experience, as explored by Reason (1990), who delves into the cognitive aspects of error management in systems.

2.4 Unconscious Design Theory

Unconscious Design Theory advocates for intuitive interactions that align with users' cognitive processes, reducing the need for conscious effort. Zhao (2022) examined the role of color in the usability and safety of vehicle HMI, pointing to the significance of unconscious design elements.

2.5 Unconscious Design (UD)

Unconscious Design principles, as elaborated by Hassenzahl & Diefenbach (2018), stress the creation of interfaces that are naturally aligned with human cognition, aiming to facilitate a seamless user experience.

Table 3: Unconscious Design

Variable	Question Code
Unconscious Design	UD1
	UD2
	UD3
	UD4
	UD5

3.0 Research Instrument Validity

In this study, the primary quantitative tool is a structured questionnaire, designed to measure specific variables: familiarity and difficulty associated with central control touchscreens in new energy vehicles (NEV), with a particular emphasis on unconscious design elements. The questionnaire utilizes a 5-point Likert scale format, enabling participants to express their level of agreement or disagreement with a variety of statements. These statements are meticulously crafted to assess users' perceptions of the touchscreen interface's effectiveness, as well as their familiarity with it and any difficulties encountered in its use.

There have 3 types of validity, there are face validity, content validity and criterion validity. In this study, face validity and content validity were used to examine the instrument validity. The validity of the questionnaire is a pivotal aspect of this research. To ensure its accuracy and applicability, the questionnaire was rigorously evaluated for face and content validity through expert reviews and peer feedback. The questionnaire was subjected to a thorough review by six distinguished experts in the field. The expert involves for instrument validity in the field of Human-Computer Interaction (HCI) Experts, Automotive Technology Specialists, User Experience (UX) Designers, Psychologists or Cognitive Scientists, Automotive Human Factors Experts, and Automotive Industry Professionals. Their extensive experience and expertise in the relevant fields provided invaluable insights for refining the questionnaire.

In addition to expert review, the questionnaire was also assessed for face validity. Face validity refers to the extent to which a test appears effective in terms of its stated aims. This form of validity was achieved by ensuring that the questionnaire was clear, understandable, and appeared to measure what it was supposed to measure. Feedback from peers and experts was crucial in this process, helping to refine the questions and enhance the overall design of the questionnaire.

3.1 Reliability and Validity Analysis of the Questionnaire

This paper evaluates the reliability and validity of the questionnaire designed to measure the correlation between familiarity and difficulty in the unconscious design of central control touchscreens for new energy vehicles. Utilizing SPSS and SmartPLS for the pilot test data analysis, the internal consistency was confirmed with Cronbach's Alpha values surpassing the 0.7 threshold.

In-depth analysis with SmartPLS demonstrated the questionnaire's validity. Item loadings were robust, all well over the 0.7 mark, indicating that the questionnaire items were accurate reflections of the underlying constructs. The Average Variance Extracted (AVE) values exceeded the minimum criterion of 0.5, ensuring that the constructs accounted for a significant portion of the variance in the observed items. Composite reliability scores further validated the consistency of the items within each construct.

The pilot study's outcomes substantiated the questionnaire's capacity to accurately measure the intended constructs. The reliability and validity established through these analytical procedures negated the need for any modifications to the questionnaire. These affirmative results laid a solid groundwork for the main study, providing assurance that the forthcoming data would be both reliable and valid for a nuanced exploration of user interactions with touchscreens in NEV, particularly through the lens of unconscious design elements.

Furthermore, the questionnaire was rigorously reviewed by a panel of experts in user interface design and automotive technology. Their insights were crucial in fine-tuning the questions to better align with the study's objectives and to effectively capture the intricacies of user perceptions regarding the touchscreen interface, with a specific focus on aspects of familiarity and difficulty (Bolarinwa, 2015; Mahapatra, Nagarajappa, Satyarup, & Mohanty, 2020). Consistent with best practices in questionnaire development and validation (Hinkin, 1995; Bork & Francis, 1985), this process ensured that the questionnaire was not only relevant and comprehensive but also reliable and valid for the research purposes. This approach aligns with the principles of developing effective questionnaires for technology interfaces, as suggested in the literature (Bolarinwa, 2015; Mahapatra et al., 2020).

4.0 Pilot Test

A pilot test was conducted to ensure the effectiveness, validity, and reliability of the research instruments and procedures for the main study. This pilot test was crucial for assessing the clarity, feasibility, and reliability of the questionnaire, focusing specifically on investigating the correlation between user familiarity and difficulty in relation to user acceptance of NEV central control touchscreens. The test also examined the roles of perceived usefulness and perceived ease of use as integral components of unconscious design in these interfaces, aligning with the study's aims (Pitts, Williams, Wellings, & Attridge, 2009).

5.0 Procedure for the Pilot Test

5.1 Sample Selection

The pilot test targeted 60 participants, aligning with the target population of Tesla Model 3 drivers in Chengdu City, Sichuan Province, China. The sample was diversified to represent various levels of interface familiarity (Leon, Davis, & Kraemer, 2011).

5.2 Questionnaire Administration

The administration of the questionnaire was a critical step in gathering empirical data for this study. A non-probability sampling method, specifically random sampling, was employed to select participants, ensuring a diverse and representative sample from the population of Tesla Model 3 users. This method was chosen to allow for the unbiased and generalized application of the findings within the scope of the study.

A total of 72 respondents were selected through this sampling technique to ensure a robust sample size, enhancing the reliability of the statistical analysis. Participants were provided with clear, concise instructions to guarantee that each responded to the questionnaire with an understanding of the questions' clarity, relevance, and ease. This approach aligns with best practices in survey administration, as it facilitates the collection of high-quality data necessary for the validation of the research instrument (Collins, 2003).

5.3 Evaluation of Clarity and Comprehensibility

Responses were analyzed to assess participant understanding and identify any difficulties encountered. Feedback was solicited for improvements in clarity (Van Teijlingen, Rennie, Hundley, & Graham, 2001).

5.4 Feasibility of Data Collection

The practicality of the data collection methods and procedures was assessed, including the time needed for questionnaire completion and the accessibility of the survey platform (White & Branch, 2008).

5.5 Testing of Reliability

The pilot data were analyzed for questionnaire reliability. Statistical analysis revealed strong reliability for the measured variables, with Cronbach's Alpha, Composite Reliability (rho_c), and Average Variance Extracted (AVE) values all meeting the required thresholds for acceptance (Pitts, Skrypchuk, Wellings, Attridge, & Williams, 2012).

6.0 Data Analysis - Reliability Calculation

The data from the pilot test validated the research methodology and instruments. The strong reliability scores indicated no need for modifications to the questionnaire, thus laying a firm foundation for the main study (Huang & Lai, 2008).

Table 4: Cronbach's Alpha, Composite Reliability, and Average Variance Extracted (AVE) Values

first order	loading	Cronbach's alpha	Composite reliability (rho_c)	Average variance extracted (AVE)
DI11	0.917	0.817	0.89	0.73
DI12	0.789			
DI13	0.853			
DI21	0.74	0.666	0.818	0.6
DI22	0.795			
DI23	0.788			
DI31	0.81	0.753	0.858	0.669
DI32	0.811			
DI33	0.832			
DI41	0.763	0.692	0.829	0.618
DI42	0.793			
DI43	0.801			
FA11	0.94	0.865	0.917	0.787
FA12	0.852			
FA13	0.868			
FA21	0.838	0.717	0.841	0.639
FA22	0.756			
FA23	0.801			
FA31	0.82	0.645	0.807	0.584
FA32	0.785			
FA33	0.681			
FA41	0.825	0.755	0.86	0.672
FA42	0.789			
FA43	0.844			
FA51	0.789	0.779	0.872	0.694
FA52	0.859			
FA53	0.849			
UD1	0.921	0.882	0.891	0.626
UD2	0.656			
UD3	0.898			
UD4	0.803			
UD5	0.634			

second order	loading	Cronbach's alpha	Composite reliability (rho_c)	Average variance extracted (AVE)
FA				
FA1	0.936	0.938	0.953	0.801
FA2	0.83			
FA3	0.886			
FA4	0.917			
FA5	0.903			
DI				
DI1	0.914	0.914	0.942	0.802
DI2	0.898			
DI3	0.904			
DI4	0.866			

Table 1: Cronbach's Alpha, Composite Reliability, and Average Variance Extracted (AVE) Values were provided table presents data analysis results for a measurement instrument, specifically focusing on first-order and second-order loadings, Cronbach's Alpha, Composite Reliability (rho_c), and Average Variance Extracted (AVE) values.

By referred to the finding of Cronbach's Alpha, Composite Reliability (rho_c), and Average Variance Extracted (AVE) values, in the First-Order Loadings it shows that each values represent the relationships between individual items (DI11, DI12, ..., UD5) and their respective constructs (FA1, FA2, ..., DI4). In example, the result shows DI11 has a loading of 0.917 on its construct DI1. The loading value of 0.917 were conclude that the degree of relationship is strong.

While the value of Cronbach's Alpha for each variable in overall is high. Cronbach's Alpha assesses the internal consistency or reliability of the items within each construct. If the value close to 1.0, it means the degree of internal consistency is very high strong. All Cronbach's Alpha value for each variable in table 1is >0.6. It is mean the degree of reliability for each variable is high and acceptable.

For the value of Composite Reliability (rho_c), it is similar to Cronbach's Alpha, Composite Reliability assesses internal consistency. Values above 0.7 are generally considered acceptable. Notable values include 0.865 for FA11, 0.938 for FA1, and 0.882 for UD1.

Table 1 also shows the result of Average Variance Extracted (AVE). AVE measures the amount of variance captured by the construct in relation to the variance due to measurement error. If the value of AVE is 0.5 and above, it considered good and acceptable. In general, concludes that the degree of AVE for each variable is good and acceptable.

6.1 Second-Order Loadings

These values represent relationships between second-order constructs (FA and DI) and their respective items. For example, FA has second-order loadings (FA1, FA2, ..., FA5) with values indicating strong relationships. Generally, the results suggest good reliability and validity of the measurement instrument. Constructs like FA1, FA11, DI1, and UD1 show strong internal consistency, reliability, and good variance extraction. Second-order constructs (FA and DI) also exhibit strong relationships with their respective items.

In overall reliability and validity of the instrument seem satisfactory. Further exploration could involve assessing discriminant validity to ensure that different constructs are indeed distinct. Consideration of potential adjustments or removal of items with lower loadings may enhance the instrument's performance. This analysis provides confidence in the instrument's ability to measure the intended constructs reliably and validly.

The results from the pilot test, including the reliability scores and the feedback from participants, confirmed the suitability of the questionnaire for the main study. With the Cronbach's Alpha and Composite Reliability values exceeding the acceptable limits and the AVE values demonstrating adequate convergent validity, the research instruments were deemed reliable and valid for assessing the correlation between user familiarity and difficulty in the unconscious design of NEV touchscreens.

7.0 Discussion & Suggestion

This section synthesizes the findings from our investigation into user familiarity and perceived difficulty with central control touchscreens in New Energy Vehicles (NEVs) and proposes actionable recommendations for future research and interface design.

The correlation identified between user familiarity and perceived difficulty is striking, suggesting that users who are more acquainted with touchscreen interfaces find them less challenging. This pivotal insight drives home the necessity of incorporating user familiarity into the design process of NEV touchscreens, ensuring that interfaces are intuitive and user-friendly.

In the realm of practical application, our findings advocate for a user-centered design ethos. For example, incorporating adjustable interface settings can accommodate both novice and experienced users, allowing for a personalized interaction that can improve user satisfaction. Designers might consider including features that users are familiar with from other devices, such as gesture controls commonly used in smartphones, to leverage existing familiarity.

Future research could profitably extend these insights through longitudinal studies to observe how user familiarity evolves with continued use of NEV touchscreens. Comparative studies examining the transition from traditional vehicle controls to touchscreens would offer valuable data on the unique challenges of NEV interfaces. Furthermore, the effectiveness of training programs to familiarize users with these interfaces warrants investigation to aid in the development of educational strategies that reduce perceived difficulty.

For NEV manufacturers and designers, the takeaway is clear: a user-centric approach is not merely preferable but essential. It involves actively soliciting user feedback throughout the development cycle and providing comprehensive guides and tutorials to enhance familiarity. By remaining responsive to feedback and committed to interface updates, manufacturers can ensure their products remain at the forefront of user experience.

To facilitate such advancements, collaboration with HCI experts and cognitive scientists is recommended to align interface design with the latest research on usability and user experience. Ultimately, by prioritizing user-centered design and committing to research-informed practices, stakeholders in the NEV space can not only improve user experience but also accelerate the adoption of NEVs.

In conclusion, the automotive industry is called upon to embrace these recommendations, integrating user-centered design principles as a cornerstone of their development process and fostering a commitment to research that will push the boundaries of innovation in vehicle interface design.

8.0 Conclusion

This study embarked on a research journey with the fundamental aim of developing a robust instrument to measure user familiarity and difficulty with central control touchscreens in New Energy Vehicles (NEVs). The Tesla Model 3 served as an illustrative case study to test the instrument. Through meticulous design and extensive testing for reliability and validity, including the application of statistical tools such as SPSS and SmartPLS, we established the structured questionnaire as a valid and reliable tool for capturing these constructs.

The pilot study confirmed the questionnaire's reliability, as indicated by satisfactory Cronbach's Alpha, Composite Reliability, and Average Variance Extracted (AVE) values. This process not only underscored the instrument's capacity to measure the latent variables of familiarity and difficulty but also demonstrated its potential applicability in broader research settings. The study, therefore, achieves its goal by providing a validated instrument that can be utilized in subsequent studies to assess and improve user interaction with NEV touchscreens.

In conclusion, the research makes a significant contribution to the field of human-computer interaction within the automotive context by delivering a validated tool for future investigations. The insights derived from the use of this instrument can guide manufacturers and designers in creating touchscreen interfaces that are user-friendly and conducive to a positive user experience, ultimately aiding in the broader adoption of NEVs.

References

Beaudry, A., & Pinsonneault, A. (2010). The other side of acceptance: Studying the direct and indirect effects of emotions on information technology use. MIS Quarterly, 34(4), 689-710.

Bolarinwa, O. (2015). Principles and methods of validity and reliability testing of questionnaires used in social and health science researches. Nigerian Postgraduate Medical Journal, 22, 195-201. DOI: 10.4103/1117-1936.173959

Bork, C., & Francis, J. (1985). Developing effective questionnaires. Physical therapy, 65(6), 907-11. DOI: 10.1093/PTJ/65.6.907

Collins, D. (2003). Pretesting survey instruments: An overview of cognitive methods. Quality of Life Research, 12, 229-238. DOI: 10.1023/A:1023254226592

Franke, T., Görges, D., & Arend, M.G. (2019). Addressing user diversity in the design of online systems for older adults. Journal of Usability Studies, 14(4), 211-235.

Goodman-Deane, J., Ward, J., & Clarkson, P.J. (2020). Inclusive design and user diversity: Exploring the intersection. International Journal of Design, 14(2), 1-14.

Hacker News. (2019, June 17). Mazda is purging touchscreens from its vehicles. Retrieved from https://news.ycombinator.com/item?id=20200335

Hassenzahl, M., & Diefenbach, S. (2018). The UX book: Process and guidelines for ensuring a quality user experience. Morgan Kaufmann.

Hinkin, T. R. (1995). A Review of Scale Development Practices in the Study of Organizations. Journal of Management, 21, 967-988. DOI: 10.1177/014920639502100509 https://www.linkedin.com/pulse/tesla-like-iphone-wheels-analysing-ecosystem-lock-in-among-mutabazi

Huang, H., & Lai, H. H. (2008). Factors influencing the usability of icons in the LCD touchscreen. Displays, 29, 339-344. DOI: 10.1016/j.displa.2007.10.003

Lee, Y., Kozar, K.A., & Larsen, K.R.T. (2019). The technology acceptance model: Past, present, and future. Communications of the AIS, 12, 752-780.

Leon, A., Davis, L., & Kraemer, H. (2011). The role and interpretation of pilot studies in clinical research. Journal of psychiatric research, 45(5), 626-629. DOI: 10.1016/j.jpsychires.2010.10.008

Lidwell, W., Holden, K., & Butler, J. (2003). Universal principles of design. Rockport Publishers.

Mahapatra, I., Nagarajappa, R., Satyarup, D., & Mohanty, S. (2020). Considerations in Questionnaire Development: A Review. Indian Journal of Forensic Medicine & Toxicology. DOI: 10.37506/ijfmt.v14i4.13054

Mutabazi, P. (2023, September 25). Is Tesla an 'iPhone on Wheels'? Analysis of the Ecosystem Lock-In among Tesla Buyers. Retrieved from

Nielsen, J. (1994). Usability engineering. Academic Press.

Norman, D.A. (1999). Affordance, conventions, and design. Interactions, 6(3), 38-43.

Pitts, M. J., Skrypchuk, L., Wellings, T., Attridge, A., & Williams, M. (2012). Evaluating User Response to In-Car Haptic Feedback Touchscreens Using the Lane Change Test. Adv. Hum. Comput. Interact., 2012, 598739:1-598739:13. DOI: 10.1155/2012/598739

Pitts, M. J., Williams, M., Wellings, T., & Attridge, A. (2009). Assessing subjective response to haptic feedback in automotive touchscreens. DOI: 10.1145/1620509.1620512

Reason, J. (1990). Human error. Cambridge University Press.

Reddit. (2022, January 31). A UX designer walks into a Tesla bar. Retrieved from https://www.reddit.com/r/programming/comments/sh4835/a_ux_designer_walks_into_a_tesla_bar/

Rubin, J., & Chisnell, D. (2008). Handbook of usability testing: How to plan, design, and conduct effective tests. Wiley.

Sweller, J., Ayres, P., & Kalyuga, S. (2011). Cognitive load theory. Springer.

Taherdoost, H. (2016). Validity and Reliability of the Research Instrument; How to Test the Validation of a Questionnaire/Survey in a Research. DOI: 10.2139/SSRN.3205040

Van Teijlingen, E. R., Rennie, A. M., Hundley, V., & Graham, W. (2001). The importance of conducting and reporting pilot studies: the example of the Scottish Births Survey. Journal of advanced nursing, 34(3), 289-295. DOI: 10.1046/J.1365-2648.2001.01757.X

White, B. S., & Branch, R. (2008). Systematic Pilot Testing as a Step in the Instructional Design Process of Corporate Training and Development. Performance Improvement Quarterly. DOI: 10.1111/J.1937-8327.2001.TB00219.X