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Elevating User Experience for Thailand Drivers: Dash-Board Design Analysis in Electric Vehicles

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***Abstract*—**This study explores the design of electric vehicle (EV) dashboards with a focus on user interaction. Findings from a Thai sample reveal a preference for physical buttons over touch interfaces due to their immediate feedback. Touchscreens lack this assurance, leading to potential uncertainty. Users' smartphone experiences create a learning curve that does not translate well to in-car touch systems. Gender-wise, females exhibit slightly longer decision times. Designing EV dashboards should consider these factors, prioritizing user experience while avoiding overreliance on smartphone principles. A successful example is Subaru XV's design, which calculates screen angles and button positions for targeted users. In summary, EV dashboards should be intuitive, minimize touch dependency, and accommodate user habits. Balancing modernity with functionality can enhance driving experiences while ensuring safety. A user-centered approach, acknowledging gender differences, will yield efficient and safe driving environments.

***Keywords*—**User Experience Design, User Experience, Electric Vehicle, Dashboard Design, Thailand driver.

I. Introduction

In the thriving landscape of EVs, as the quest for sustainability drives innovation, the design of the driving experience becomes a pivotal arena of transformation. EVs not only redefine transportation modes but also prompt a reimagining of the cockpit—a dynamic interface where technology meets human intuition. Focusing on the unique needs and preferences of Thailand users, this research undertakes a comprehensive exploration of dashboard design within the EV context. The primary aim is to unveil how dashboard design aligns with user experience principles for brands including Lexus, Honda, Mazda, Nissan, MG, BYD, and Tesla, within the diverse automotive landscape in Thailand.

For Thai drivers embarking on electric mobility, the dashboard is more than an assembly of instruments; it is a space where safety, information, and aesthetics converge. The design of this interface shapes the driver's experience, facilitating seamless access to real-time data, navigational guidance, and critical alerts. In the context of Thailand's unique driving environment, dashboard design plays an even more crucial role in communicating essential information, fostering safety, and ensuring a harmonious blend of technology and the human driving intuition.

This research magnifies the intersection of user experience design and functional safety within the cockpit of EVs. The distinct characteristics of the Thailand user base cultural preferences, driving habits, and ergonomic needs shape the very foundation of dashboard design. With a focus on user-centered aesthetics, intuitive control placement, and minimization of cognitive load, the dashboard emerges as a vessel to enhance situational awareness, reduce distractions, and elevate overall safety, thereby amplifying the user experience for Thai drivers.

Delving into the specifics of dashboard design, this study endeavors to unearth design principles, psychological cues, and ergonomic factors that resonate with Thailand users. The analysis will traverse a multitude of dimensions, encompassing interface layout, color psychology, tactile feedback, voice interaction, and the integration of adaptive lighting unifying these aspects with a clear intent to enhance usability, aesthetics, and user engagement.

Additionally, this research acknowledges the ongoing evolution of autonomous driving and its ramifications for dashboard design. As Thailand drivers gradually shift from active control to supervisory roles, the dashboard assumes an essential role in bridging human-machine interaction, guiding passengers through an automated journey, and providing situational awareness.

This study serves as a beacon within the realm of EV design, spotlighting the indispensable role of dashboard design in shaping user experience and safety for Thai drivers. The synthesis of aesthetics, technology, and user-centricity within the cockpit mirrors the strides achieved in aligning form and function. By unraveling the intricate links between design and user satisfaction, this research strives to offer insights that empower designers, manufacturers, and stakeholders to cultivate intuitive, safer, and more enjoyable EV cockpits accelerating Thailand's journey toward sustainable and user-focused transportation.

II. Literature Review

The study conducted by Persson and Rundqvist delves into the subject of "Design of Instrument Cluster for Automobiles" [4]. The research presents a method for designing automotive instruments that are suitable for both technology and user groups. The study examines variables impacting decision-making, specifically differentiating between male and female users. Among male users, a preference is observed for diverse data representation, reflecting a sense of authoritative control. In contrast, female users favor instrument cluster designs that are minimalist, sophisticated, and straightforward, aiming to enhance the driving experience.

Osiurak et al.'s research titled 'Digital, Analogue, or

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Redundant Speedometers for Truck Driving: Impact on Visual Distraction, Efficiency and Usability' [2] discusses the design of speedometers with an emphasis on user safety. The study emphasizes the importance of non-complex data representation, whether in analog form using needle indicators or in digital form with comparable efficiency. The presentation of information should be clear, and data arrangement should be within optimal range to minimize confusion during information retrieval. They also highlights the significance of speed display accuracy to mitigate visual distraction from the road, thus reducing unexpected events.

In 2021, Osiurak et al. conducted research on 'Usability and Acceptance of Truck Dashboards Designed by Drivers: Two Participatory Design Approaches Compared to a User-Centered Design' [3], in collaboration with Volvo, an automotive manufacturer. The study focused on user-centric dashboard design, employing data from both professional truck drivers and general drivers. The findings were applied to diverse dashboard designs, including adaptations for the hydraulic fluid distribution system in trucks. The collected data underwent testing on a driving simulator, integrating user feedback gathered from questionnaires and interviews. The study concluded that user-centric dashboard design outperformed technology-oriented design, aligning with Volvo's 2009 research [1], which highlighted the effectiveness of warning messages via instrument clusters. This approach significantly reduced accident rates, specifically rear-end collisions at speeds of 30 kilometers per hour, by up to 60% in dense urban traffic conditions of France. The complexities of driving in urban environments, combined with slow-moving traffic and high cognitive demands on drivers, led to tense decision-making scenarios during driving.

Contemporary electric car manufacturers have integrated cutting-edge functionalities into their vehicle instrument clusters, aligning with user requirements, stimulating interest, and bolstering electric car sales. Drawing insights from a study conducted by the Swedish news agency Vibilagare, electric cars equipped with digital screens were evaluated for their instrument cluster and interior cabin design to assess safety during operation. Notable models, such as BMW iX, Dacia Sandero, Hyundai Ioniq 5, Mercedes GLB, MG Marvel R, Nissan Qashqai, Seat Leon, Subaru Outback, Tesla Model 3, Volkswagen ID.3, Volvo C40, and even the 2005 Volvo V70, were subjected to testing scenarios that required drivers to focus on information displayed on digital instrument clusters and control panels through more than 15 simulated situations.

The study involved timing the duration of interactions for each scenario and subsequently comparing these interactions with the distance covered during driving. The outcomes unveiled that driver, on average, divert their gaze from the road for approximately 24.3 seconds per driving session. In practical terms, if a vehicle travels at a speed of 100 kilometers per hour, a driver's visual diversion results in the car moving uncontrollably for at least 500 meters [6]. These findings directly impact the safety of both drivers and passengers within the vehicle.

III. Methodology

This study adopts a qualitative research approach utilizing a survey research format, employing questionnaires as a tool for data collection within a one-shot description study and there is a test control distance to enter various commands that are important in driving by using MG4. The research population comprises electric vehicle drivers available for purchase in Thailand, with a maximum retail price of 1,500,000 Thai Baht, and a continuous usage behavior of at least 6 months. The population is divided into two groups: vehicle owners, totaling 17 individuals, and non-vehicle owners, totaling 3 individuals. The sample selection process involves purposeful sampling.

The methodology consists of three steps:

- 1. involves selecting regions with a significant population of EV drivers, including Bangkok, Pathum Thani, Nonthaburi, Samut Sakhon, Samut Prakan, and Nakhon Pathom.
- 2. involves collecting data from the sample groups, with appointments scheduled on weekdays, official holidays, and non-working holidays to ensure convenient questionnaire completion.
- 3. involves data collection from 20 individuals across the six provinces.

To validate the quality of the research tool, validity testing was conducted. The questionnaires were subjected to expert opinions, encompassing academic advisors and industry experts with over 10 years of experience in the automotive field. Their expertise included designing various functions of conventional vehicles, coupled with a clear understanding of EV behaviors. The tool gained acceptance from various institutions within Thailand and underwent content clarity assessment, as well as refinement and verification for alignment with the research objectives. Subsequently, the validated questionnaires were administered to the sample group, willingly participating in the survey.

The distribution of questionnaires was facilitated through the online platform Microsoft Form. The survey inquired about the utilization of data prioritization, evaluating whether the respondents employed this prioritization for data representation on measuring instruments. The collected data from the sample group's questionnaire responses were summarized, consolidating perspectives, and subsequently presented in line with the focal points of the research questions.

IV. Result

Based on the results of the questionnaire administered to a sample population concerning the design of electric car dashboards, it was observed that over 80% of the sampled population is familiar with a design wherein the control panel features physical buttons. When these buttons are pressed to initiate specific functions, they execute a single command. Conversely, only around 20% of the respondents favor a design that relies on touch-screen commands for control panel operations. Subsequently, the selected participants were engaged in conducting reactions for inputting commands to execute vehicle functions. The details of these reactions are

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outlined in Tables I and II.

TABLE I
TABLE OF REACTIONS WHEN RECEIVING INSTRUCTIONS FROM THE MALE.

No	Task	Reach distance. (centimeter)	Time of performance. (second)
1	Activate the emergency lights.	65	1
2	Turn on the Air-condition.	68	1.2
3	Turn on the Engine.	60	0.8
4	Turn of the lane keeping assist	70	4
5	Volume Down the music	66	1
6	Volume Up the music	65	1

TABLE II
TABLE OF REACTIONS WHEN RECEIVING INSTRUCTIONS FROM THE FEMALE.

No	Task	Reach distance. (centimeter)	Time of performance. (second)
1	Activate the emergency lights.	59	1.5
2	Turn on the Air-condition.	61	1.4
3	Turn on the Engine.	48	1.2
4	Turn of the lane keeping assist	62	8
5	Volume Down the music	57	1.2
6	Volume Up the music	59	1.5

The design of car windshields and the test results reveal that the seating position of males is situated further from the command buttons, enabling them to input commands more quickly compared to the female counterparts due to their anatomical configuration, agility, and faster decision-making capabilities.

A. Interview Summary: Mr. Tanatap Thanesnirattanasai, an Automotive Expert in Thailand [7]

The design of car windshields and dashboards necessitates a paramount consideration for user interaction. This entails various aspects such as the angle of the display screen, buttons, tactile surfaces, and even the placement of different elements that communicate with the car driver. Analyzing designs from as early as the year 2017, a notable exemplar is the second-generation Subaru XV, which has been recognized for effectively positioning communication elements and responsive buttons within immediate reach. This design philosophy is rooted in instant control and comprehension of the displayed information, even ascertaining the optimal triangle theory positioning of driver and vehicle within the cabin space. Consequently, this facilitates an exceptional driving experience through efficient design of the car chassis.

The inclination angle of the display screen and the positioning of functional buttons must be meticulously calculated to align with the specific target group of each car model. Such meticulous alignment ensures peak efficiency in usage. Nonetheless, in contemporary times, general car users tend to desire larger displays that are user-friendly and contemporary, thereby prompting several car manufacturers to expand the size of car screens. This facilitates easier decision-making for potential buyers. However, this expansion poses a challenge for effective design and communication, and hence, various car manufacturers have turned to mobile phone interface design behaviors. Yet, these approaches may not entirely fulfill the usage and safety needs. Presently, the most adept solution lies with the Apple CarPlay system, which offers swift communication with users and the rapid dissemination of data.

Honda Automobile, adopting the philosophy of "man maximum, machine minimum" or "mega minimum," as demonstrated through the Honda Civic in 1972, exemplifies an instance where communication elements have been presented effectively and without unnecessary clutter on the car's dashboard. This design philosophy, demonstrated prominently in models like the 2021 Honda Civic, 2021 Honda Accord, and the EV Honda E, remains consistent. Moreover, Honda has maintained a design approach rooted in clockwork positioning, aiding ease of communication and user understanding, unlike many other companies. Additionally, Mazda has introduced user interface modifications that effectively balance design, manufacturing costs, and affordability. This approach caters to the general consumer and subsequently leads to an enriching driving experience.

In defining an ideal driving experience, it is imperative to understand the purpose of a car and its intended users. If a car caters to homemakers, it must seamlessly integrate into their daily needs. Conversely, if the car is designed for driving enthusiasts, the layout of equipment must ensure easy accessibility, convenience, and control, even at high speeds. Everything must be within the line of sight and within reach, ensuring that users can interact within the span of a single hand movement.

"It is natural for some technological designs, as conceived by automotive engineers, to be considered beneficial. However, it is essential not to overlook the general populace's familiarity with conventional innovations. Adapting to new technology becomes challenging if it feels excessively difficult. Even if the technology is advantageous, individuals might resist it. This is the essence of human nature." This must be a primary consideration for designers to create an optimal electric car driving experience for the future.

B. Interview Summary: Mr. Pansawat Paitoonpong, an Automotive Expert in Thailand [5]

The interview covered the trends in automotive instrumentation and control evolution from the past to the present, highlighting five key factors that have contributed to these changes:

Vehicle Performance: The design of automotive instruments began with placing essential gauges in the driver's view to display necessary information. Over time, this evolved in alignment with technological advancements, incorporating new features and functionalities into the console.

User Objectives: Instrumentation designs are now tailored to display relevant information directly related to the specific vehicle. This approach aims to present the most efficient and driver-friendly data, enhancing safety for the driver.

Country-specific Safety Standards: Different countries have distinct regulations regarding instrumentation displays. For instance, Japan enforces a speed limit on displayed information not exceeding 180 kilometers per hour. Designers adapt displays to ensure compliance with local laws and safety

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standards.

Vehicle Electrical Systems Technology: Technological integration within vehicles enhances driver convenience significantly. As technology advances, manufacturers must create efficient displays and control systems that allow drivers to manage various vehicle technologies effectively while maintaining focus on driving.

Market Trends and Product Differentiation: In recent years, consumers seek vehicles that align with their daily technology use, such as smartphones. Automotive companies design instrument panels to accommodate these devices, offering a unique selling point that appeals to consumers.

The evolution of automotive instrumentation has transformed vehicles across various categories. From early analog displays featuring needle indicators to modern digital displays with intricate graphics, the focus has shifted to enhancing safety through advanced technologies. These advancements have led to innovative instrument designs and control panels, contributing to the overall driving experience. However, consumers remain the ultimate judges of good design, considering the primary objectives of instrumentation and vehicle control.

V. Conclusion

The experimental results can be summarized as follows: The design of EV dashboards, as studied through a sample population in Thailand, indicates that most users prefer a dashboard design with physical buttons rather than touch-based interaction. This preference is attributed to the fact that most testers believe that command execution should provide feedback upon button press, enhancing their perception of the successful execution of the command and instilling confidence in its operation. In comparison, touchscreen interfaces do not inherently provide confirmation of executed commands, potentially leading to uncertainty regarding the actual outcome of the command and necessitating extra visual attention to determine results. Moreover, the experiences of users with touch-based interfaces, primarily via smartphones, tend to create a learning curve that can lead to undesirable interactions when applied to in-car touch systems. Such undesired interactions may include misaligned touches with buttons or buttons failing to respond to touch inputs. In the context of EVs, however, such learning curve interactions are less acceptable due to the risk of creating dangerous situations caused by incorrect command execution or the potential for commands to get stuck in the system during touch interactions.

Furthermore, the usage experiences between males and females exhibit distinct characteristics, particularly in terms of reaction time when issuing commands in response to certain events. Females tend to take slightly longer to make decisions compared to males. If dashboard designers fail to consider the sequence and placement of command buttons on the dashboard, it could lead to usability issues and potential accidents due to erroneous command inputs or delayed responses. In this regard, engineers responsible for designing both the dashboard and the layout of various controls within the vehicle should prioritize user experience. This should be achieved without overly relying on design principles derived solely from touch-based interactions on smartphones, which might not be entirely suitable for designing automotive interfaces.

The design of car windshields and dashboards places a significant emphasis on user interaction, encompassing various factors such as display screen angles, button placement, tactile surfaces, and component positioning for effective communication with drivers. Expert interviews highlight the design approach of the second-generation Subaru XV, which accurately calculates screen angles and button positions tailored to each model's target audience. This ensures confidence in usability and maximizes efficiency.

While contemporary users prefer larger, modern displays, expanding screen sizes poses challenges in design and communication. The design of the driving experience must align with car objectives and user needs, integrating seamlessly into daily routines or offering accessibility and control for driving enthusiasts. Proper placement of equipment within reach and within the driver's line of sight is essential.

The design of dashboard panels initially focuses on placing necessary gauges within the driver's line of sight to provide essential information and display relevant data directly related to the vehicle. This enhances efficiency and user experience. A good design experience also contributes to improving the driving experience across different vehicle types, transitioning from analog needle indicators to modern digital displays. Safety enhancement through advanced technology has become the primary focus.

Moreover, automotive engineers tasked with designing EV dashboards should prioritize the creation of a positive user experience while driving, rather than solely focusing on cost reduction, and consolidating all commands onto a touch screen interface. Although a contemporary and engaging design might effectively captivate users, a design that heavily relies on touch screen interactions for operational tasks could potentially lead to unfavorable usability and driving experiences. For instance, certain electric car models are equipped with large TFT screens to display various vehicle information and serve as the interface for driver commands. However, if these screens encounter malfunctions and fail to display any information, users would be unable to control the EV effectively. Furthermore, tests conducted by Vibilagare, a Swedish news agency [6], have indicated that the use of touch screen interfaces in cars could result in prolonged eye-off-road time and contribute to vehicles moving more than 500 meters without driver control.

In summary, it is crucial for automotive engineers to consider creating an intuitive and efficient dashboard design for EVs that enhances the driving experience, ensuring that functionality is not overly reliant on touch screen interfaces. This approach will contribute to a safer and more user-friendly driving environment for both male and female drivers.

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