



International Virtual Colloquium on Multi-disciplinary Research Impact (2nd Series)

Organised by Research Nexus UiTM (ReNeU)
Office of Deputy Vice Chancellor (Research and Innovation)
Universiti Teknologi MARA 40450 Shah Alam, Malaysia, 15 June 2022



Conceptual and Production Version Connectivity: Conceptual framework model

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Abstract

New product development, such as strategic conceptual designs, requires maximum effort, resources, expertise, time, and cost. However, due to unclear concern factors from various stages, these had changed the final design differently. Thus, this paper presents a theoretical framework model for performing design research, specifically in studying inconsistent design elements and factors that contributed to the new product development process. The triangulation of data collection from literature review, interviews and design experiments will establish the specific character of designers concern towards achieving the objective of the optimization NPD process.

Keywords: Conceptual Design; Final Design; New Product Development

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DOI: <https://doi.org/10.21834/ebpj.v7i1S17.3778>

1.0 Introduction

The sustainability of company businesses depends on the new product development (NPD) activity. 'Design in all its form was born within a business environment to meet the need and serve the business purposes' (Siran and Anwar, 2020; Cuffaro and Zaksenberg, 2013). In research and development activity (R and D), the role of design and other disciplines included conceptual design, cultural evolution, and collective and generational design process. All accusations of converting actual to preferred situations are concerned with design Schön (1983). The design approach will impact product demand increase, realign business directions, and promise new prospects and strategies. The booming business of Dyson and Tesla relies on their aggressive research and development (R and D) activities, continuously producing innovative products that change the nature of human behaviors, social interactions, daily lives and how they think. Cuffaro (2013) added design is helping the business hunt for sustainable advantage in the consumer preference market, reflecting its profit improvement. The 'consumer preference' refers to the product improvement at major or minor developments. Meanwhile, fulfilling the endless user demand for new innovative products is crucial in the new product development process (NPD) context. Some good products have successfully changed the way consumers think, work and manage their daily routine. Dyson 360 Eye and the autonomous vacuum cleaner were launched in 2015, Tesla Autopilot cars, released in 2014, featured self-parking changes, auto centering lane, traffic awareness cruise control, etcetera. However, several challenges exist in achieving the objective of conceptual product development, established in the earlier stage of the NPD process. It's targeted to shorten the market timeframe, accessibility to new technologies and

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DOI: [https://doi.org/10.21834/ebpj.v7i1S17%20\(Special%20Issue\).3778](https://doi.org/10.21834/ebpj.v7i1S17%20(Special%20Issue).3778)

develop better products in a large quantity (Owens and Davies, 2000). Typically, The NPD practice is executed through a sequential process which requires specific time segments at each stage. The 'step-by-step process' begins with an initial idea or concept, design development, validation, and production phase (Kazimierska and Grebosz, 2017).

"Sometimes the design solution of the public issue is toward prediction of consequences which is sometimes worse than the actual issue they propose to solve" (Siran and Anwar, 2020; Schön, 1983). For this reason, each stage consists of different requirements and factors to be achieved. In fact, before finalizing the new product design for the market, a different version of the initial conceptual idea was developed. In order to gain better clarification of design content, as well as to enhance the understanding of conceptual design, the 3D models of the prototype were built. The company will debut the concept models to the public to acquire firsthand consumer feedback on various factors of product usability, aesthetic value, style, product function, etcetera. The feedback is critical for the marketing strategy before the product is officially launched in the market. This preview session has several setbacks, with specific requirements, insisting on a different concern of issues and solutions arranged by different knowledge experts. However, clashes of different intentions, requirements and perceptions from the concept design toward the final stages resulted from turning back to previous processes. For this reason, therefore, the design flows will be affected by slow progress (Siran and Anwar, 2020). Nevertheless, an inconsistent character from both conceptual versions to the production version appeared which often does not carry forward some product elements, such as the design aesthetic, product characteristic, features or product details. Many yearly events debut new product concepts locally or internationally, namely the CES Europe, Tokyo Product Show, Beijing Innovation etc. Through observation, some inconsistencies appeared in the concept model car of Dodge Power Wagon in 1999 and the production version of Dodge Power Wagon in 2005.

In addition, the concept model car of the 2006 Kia Soul, released at the North American International Auto Show (NAIAS) in Detroit, had several changes to the production model, which was launched in 2010. This scenario also exists in local industries, research and development-based business (R and D). The Proton Tuah concept model, for instance, debuted at the 2010 Kuala Lumpur International Motor Show (KLIMS) and carried a different characteristic to Proton Preve, which was released to the public in 2012. In these contexts, the characteristic to remain, remove or improve is unclear. The concerning factor that influences the final decision made by the NPD team and management needs to be clarified. Subsequently, there is a need to understand the process and the roles played by different parties toward the final decision. Without an in-depth study to clarify these queries, it will waste resources, expertise, research effort, time, cost and etcetera. Zu'bi and Ghaleb (2015) mentioned that, in reality, most new products did not make it to the launching stage. They also mentioned that those launched faced a failure rate of twenty-five to forty per cent on average. This study aims in exploring product development processes from concept to final design, incorporation of Malaysian identity and elements of form-giving design. The specific objective of this paper is to review the design factor of product optimization and pattern of design characteristic from concept stage to final design stage.

1.1 Design thinking from different disciplines

In the context of NPD, different design thinking existed, observed in multidiscipline organizations that consist of three majors of Art-Based Design and Engineering Design. They mainly determine the decision in the process from conceptual until the final product. Art-Based Design (AD); the art-based designer's intention is toward product appearance: aesthetic, form structure, color, surface texture and finishing. 'The design approach towards different principles of designing visual elements and the combination of different form structures' (Siran and Anwar, 2016; Akner-Koler, 2000). Meanwhile, the Engineering Design (ED) approach goes toward individual knowledge, discipline and experience level. It also insists on being problem-based with cooperative work through 'Concurrent Engineering and Optimal Design' (Xu, et al., 2007), which requires specific information, structured quantified or systematic form. The product technical and the process of development determine the design concept direction.

Furthermore, the 'Function-Based Design' theory, through the 'Domain position' concept from Pahl, et al., (2007) stressed the knowledge with experience of particular persons, the influence factors, and the category of issues. Tjalve (1976) initiated the 'quantified structure' concept, connecting product function and design elements. The design thinking towards specific technical knowledge collaboration among the different domains becomes a challenge. In this context, it was proven that the design thinking intention and approach are different, influencing the decision's dissimilarity at each stage of the NPD process.

1.2 Product optimization

Besides the capital size of business operations, efficient design management is crucial for a company's performance and its future development. A design concept contains innovation which requires some refinement. Science and technology development influence complex products; innovation is crucial for NPD (Yang and Hsu, 2019). However, product innovation is just a conceptual design Assink (2006). Specifically, design strategy involves future quality products and production costs. In the design phase, product cost is 5%, but the detail design activity determines 70%-80% of product cost (Williams, et al., 1995). In the perspective of new product development (NPD) efficient management should define and be well conducted, mainly on the processes (Rut & Wolczański, 2016). However, the NPD activities were individually separated. The NPD performance consists of the product concept effectiveness on the one hand and the development process effectiveness on the others (Pullen, et al., 2010). Product Optimization consists of various contexts of quality, based on product, user, manufacturing, value and transcendent (Garvin, 1984). Optimal design is challenging through the traditional step-by-step process, especially in the design strategy and functional design (Yang & Hsu, 2019). For this reason, product optimization will influence the effective design management by choosing the best option from the range of possible choices. Moreover, the approach is commonly applied for designing the new product whereby effective design management will determine the design strategy, which is a basis to establish the design concept.

1.3 New Product Development (NPD) process

No doubt many companies have realized the importance of new product development to their business performance (Bhuiyan, 2011), where the main factors lie in the business planning, profit performance and overall growth of the company (Dhargalkar, et al., 2016; Cooper, 2001). However, the processes of NPD are costly, complicated, time consuming, and highly risky (Cooper, 2001). Through the complexity of processes, it might change with time, usually unplanned as well as unpredicted. However, the majority of new products do not reach the launching stage despite the failure rate of 25% to 45% (Cooper, 2001). The Typical NPD practice approached a sequence of stages known as the step-by-step process, which begins with the initial conceptual idea or an assessed idea, followed by the development, testing and market launching (Bhuiyan, 2011). Owens and Davies (2000), also admitted once the process stage is completed, the acquired information was transferred to further divisions. However, this approach proved that the functionality and effectiveness elements are repetitive, leading to an 'over the wall' pattern of division, possibly becoming problematic, increasing the time consumed and extending the amount of changes to the following engineering process (Bhuiyan, 2011). Besides the late design changes which are costly, counterproductive, and bring a negative image to the company. Williams, et al., (1995) stated that the overall design changes created overspending, higher than the total amount of the effects which should be allocated to the single changes. In this context, the current step-by-step method invites challenges to the process flow despite contributing to the consistent design element towards the conceptual and final design stage.

1.4 The conceptual ideation

Constructing such promising and outstanding conceptual designs for new products are critically needed for the NPD process. Bargelis (2007) asserted conceptual design plays a significant role in developing new products that influence the quality, cost, manufacturing and products life cycle. Kazimierska and Grebosz (2017) emphasized the importance of concept ideas that determine the NPD process's success. The ideation activity is part of the product concepts generation process which is typically required to produce numerous ideas to be reviewed where the most outstanding one will be selected for further development process Mahmutllari and Jonis (2014). The ultimate purpose of idea generation is to produce a wealth of ideas. The criteria of initial ideas at the early concept stage are 'can do' basis restricted to specific requirements to be met. An example of design criteria that caused idea rejection is the resource availability and insufficient idea development etcetera (Mahmutllari & Jonis, 2014). Furthermore, the area of interest needs to be determined well, so that the nonprofit executives are able to look at the specific environment for the growth opportunities. Conceptual ideas should influence any potential sources: employees, customers, and vendors, apart from approaching new unique features and advanced ideas for pursuing advanced automobile design (Lv & Lu, 2012). The automotive industry shows a prominent conceptual design ideation in NPD activity rather than other category products. The design of a concept car can be easily understood through maximum exploration of future concept features, however, seldom involves both concept design stage and the production stage (Owens & Davies, 2000).

1.5 Formgiving design

Mulder-Nijkamp and Corremans (2014) and several authors have concluded that consumer responses are significantly determined by visual appearance and aesthetic experiences that are evoked by good form. Additionally, 60% of respondents in one survey of senior marketing managers, mentioned design as the most critical determinant of new product performance (Bloch, 1995). He added, the meaning as applied art, product design has a significant impact on our daily lives more than other art forms. This is because we see and use products daily. Furthermore, design education has many potential benefits of incorporating formgiving understanding and form development process. This is because aesthetics plays a significant role in product design. Abidin, et al., (2008) also stated that the users can correspond formgiving with elegance, efficiency, alertness and robustness. Users are more likely to perceive a modern car as elegant and efficient and perform well when formgiving features are incorporated into the layout. In addition, the usage of animal form in car styling can have a broader appeal, as users tend to associate animals with elegance and efficiency. According to Bloch (1995), designers have the power to make choices regarding characteristics, such as shape, scale, proportion, materials, tempo, color, reflectiveness, ornamentation, and texture. Additionally, Abidin, et al., (2008) mentioned that the most crucial part in making the product appearance outstanding in the design process is during form creation. Undeniably, ideation and inspiration for forms are usually linked together. Mulder, et al., (2014) also stated that more experienced designers think in a way that 'idea' and 'form' surface simultaneously. However, despite differences, some similarities of design character remained from the conceptual design stage to the final production version. The base form, the main component, primary structure, and overall size are kept.

2.0 The development of theoretical research frameworks

In order to strengthen the research fundamentals, three design research models were referred to: Frayling (1993); Cross (1999) and Fallman (2008). But, Frayling (1993) research on design is possibly performed through three approaches, 'Into Design' (design history), 'Through Design' (industry method) and 'For Design' (through practice). Meanwhile Cross (1999) emphasized the involvement of people, process and product for investigating the design research. Fallman (2008) insisted on the interrelation of three elements which will determine the success of design research; Design practice, Design Studies and the Design Exploration. For this reason, therefore, the study focuses on the design process, product and designer. The research process begins with the literature review to clarify specific terms related to the topic and the research contexts. The information collected from past research will determine the rule of the current research (Anwar, 2016). The data analysis gathered from the empirical study will be further compared to profile the specific factors that contributed to the knowledge gap. In the design experiment activity, the most critical part is to understand how designers think about the formgiving process (Abidin, et al., 2008). For this reason, the divergent and convergent process flow was approached (Siran, 2016; Anwar, et al.,

2015), which led to rigorous studies on related contexts from various perspectives (Figure 1). As well as the basis of the final design solution approach for this research was inspired by the ablation designs concept, which evolved through the theory of formgiving design as shown in Figure 1. The pattern of design research constructed by Anwar influenced the development of a theoretical framework for this research (Figure 2), by segregating the process of research activities. Therefore, this research will focus on three main factors which are theoretical factors; previous research aligns with this topic, design factors, design process practiced for the development of conceptual design stage and human factors; are the concern factor for conceptual and final design stages.

All the factors are divided into three main areas of the research framework (see Figure 3), to achieve the three goals, which mainly investigates the concern factor from the conceptual design to production stages in the NPD process.

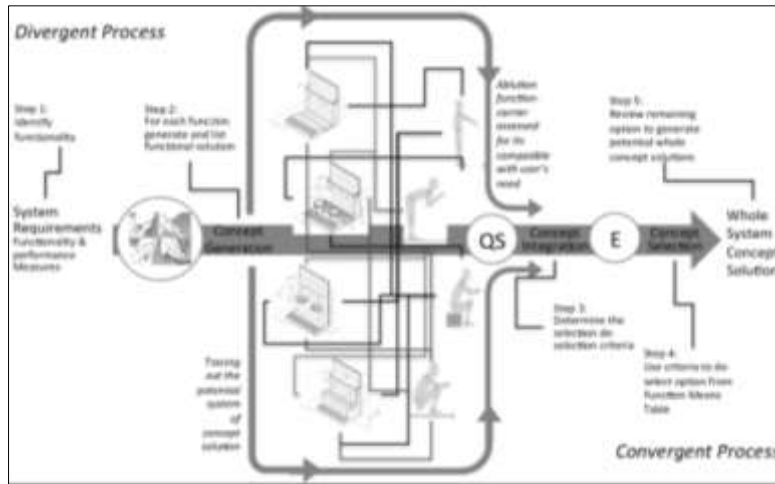


Figure 1: Divergent-Convergent Process
(Source: Anwar et al., 2015)

3.0 Method

3.1 Literature Reviews

At the early stage, reviews on specific literature that clarifies fundamental terminology and character of particular contexts are relevant to the research title. The reviews focus on product optimization, design concept (local culture elements) and formgiving. Besides, all information gathered from the literature review was arranged based on the process flow, context area and connection, which influenced the conceptual framework in Figure 2. Moreover, it leads to the development of a detailed process flow of the research framework in Figure 3, inspired by the design research methodology model (DRM) (Blessing and Chakrabarti, 2009). The DRM consists of three phases of research objectives. Meanwhile, the research scope includes the product optimization, the designer approach to composition between local culture elements and usability factor into the design concept of an autonomous car (the subject study), the influence factor of design concept and the production in the NDP process.

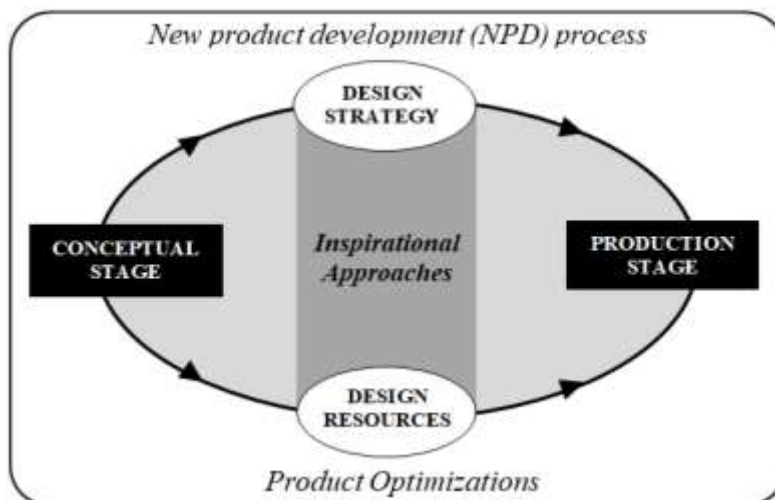


Figure 2: Theoretical Framework constructed from literature review

3.2 Design Protocol Analysis (DPA)

In the second phase, the design experiments conducted through the Design Protocol Analysis (DPA), was to identify designers thinking on problem solving concerning particular themes (Siran and Anwar, 2020; Anwar, 2016; Abidin, et al., 2008; Warell, 2001). The DPA setup within a controlled environment included the design brief, which was to be observed and approached to five expert levels of product designers with more than twenty years of experience. The task required them to design by drawing sketches, with the theme of autonomous concept cars, embracing the local culture elements to function and commute within the capital city of Putrajaya. It also used three sets of videos and voice recording devices, positioned at different angles to observe the design activity.

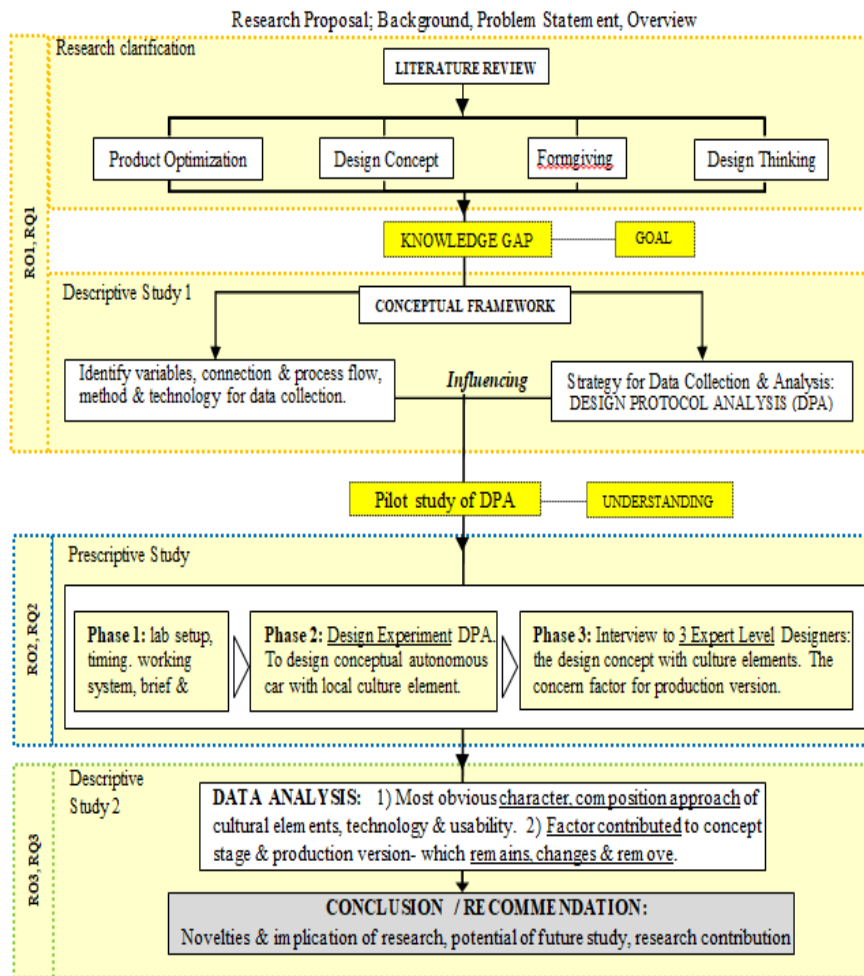


Figure 3: The Research Framework adapted from DRM model

3.3 Interview

In the third phase, two sessions of interviews were conducted with the same respondents, to review the factor effect on design, especially related to the production version. The first session clarified the cultural element approach to conceptual autonomous car design. In contrast, the second session identified the concern factor for the production process to the same design concept drawing. While considering the production process, designers need to describe the rationale and the factors contributing to the production by indicating particular parts needed for change or remain from the same conceptual drawing sketch, using different color drawings. The data from both sessions will analyze the pattern of designer's influence factors, the strategy and resources of forgiving, the adaptation process of culture elements combined with technical, and the usability factors between conceptual design and the production version. The overall research methodology is shown in Figure 3.

4.0 Findings

The findings from interviews with expert designers on concept ideation, implementation of visual elements and its meaning as well as design development are presented in Figure 4..

4.1 Concept Ideation

On the question of factors influencing concept design, all respondents mentioned market demands and trends, retrieved from consumer research plays a major factor in developing ideas for conceptual stage. All respondents agree on having a thorough and concrete design brief from a compressive project research/planning influence their design the most. Most respondents agree that car proportion is a challenging area while designing the exterior form of the car. The concern with car proportion includes height, the location of tires, design balance, door trim, and proportion detailing. The front face of the car is also one of the most challenging parts to design as there are many components and regulations surrounding the area. Thus, making it an area that tends to have many modifications throughout design development.

4.2 Visual Elements Implementation and its Meaning

Respondents imply the importance of implementing the 'essence' or the 'soul' into a design through understanding design elements. A respondent mentions on 'Many designers in different parts of the world, different countries, have tried to bring their heritage, their DNA, to the car design which for the most part cannot be translated directly.' As a result, a designer is required to simplify or extract key lines from visual elements and apply them to the design. For designers, the creative process begins with understanding, extracting, and simplifying elements.

4.3 Design Development

An educated guess based on designers' experience; it shows similar patterns among the five respondents, indicating that a high percentage of design is translated from concept to production. With an average of 84 percent of design carried forward into production. Engineering constraints, market demands and reactions, costing, and management decisions were also mentioned as common limitations by respondents. Several factors on late design changes in production and design development were highlighted by respondents. Manufacturing costs, project budgets, engineering considerations such as manufacturing limitations and technical issues, market reactions, and management decisions are just a few examples.

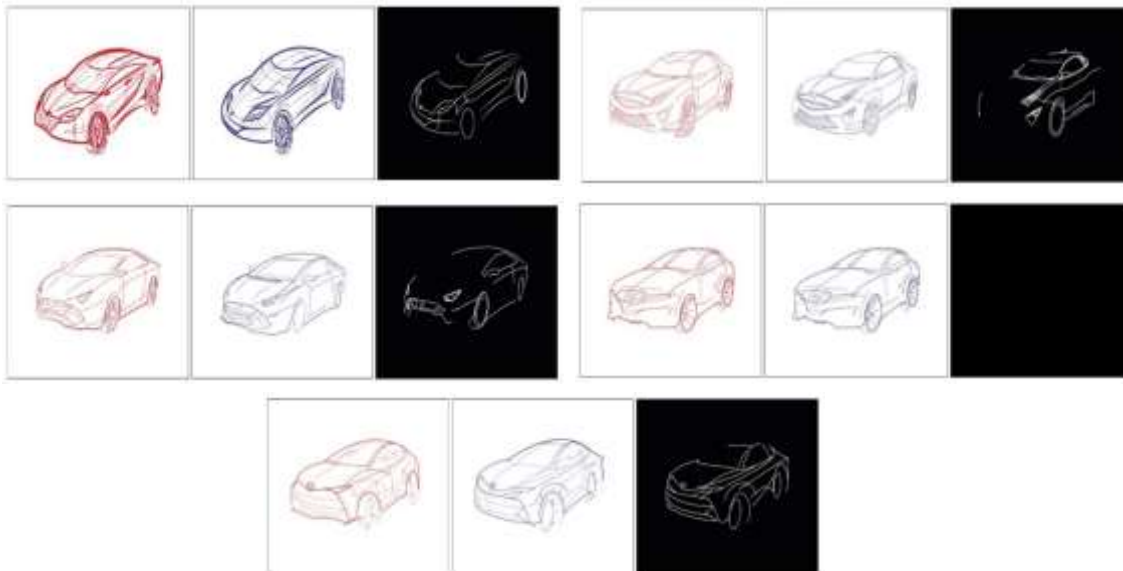


Figure 4: Analysis of Inconsistencies of Line and Form Between Concept Sketch and Post Production Sketch from DPA Sketches

Table 1 shares the analysis of line inconsistencies on the exterior form of the car, the majority of respondents have made design changes to the general proportion of the car design. The size of the wheels, wheel arch, rocker panel, body trim, and window panels on the side of the car, as well as the front bumper, headlights, and parts of the hood panel on the front side of the car, have all undergone design changes. Most of the proposed designs for concept cars and production cars look similar because the essence of the design is maintained from the concept sketch to the production sketch. The design inconsistencies that occur during this drawing activity occur after taking engineering limitations, technical issues, adding details, and adjusting the overall proportion of the car design into account.

Table 1: The Overall Summary Analysis of Pattern of Characteristic Changes and Design Meaning Implementation from DPA Sketches

Patterns	Discussion
Design Inconsistencies	80% of design were modified on wheel, headlights, roofline and side skirt, window panel, side character line 60% of design were modified on air intake and front grill, body trim, hood panel 40% of design were modified on back bumper
Visual Elements and Design Preferences	60% of the respondent uses tiger as inspiration. 40% of the respondent uses wau as inspiration. 20% of the respondent uses keris as inspiration. All respondent focus the application the visual elements on the front.

Design Meaning	Zoomorphism (character design) Malay Identity
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5.0 Conclusion

To sum up, was profiled the formgiving process of composing the cultural elements, technology and usability factor into the design concept. Through the conceptual design, further identified which factor remains, changes or are removed for the production version. On the completed design concept, further profiled which cultural element character has conspicuous prominence. The research findings clarified certain factors from the designer's thinking that contributed to the differences and similarities of both stages. Further future work is needed for the research on the concept of design management organization and process system which could minimize the difference between conceptual design and production version.

Acknowledgements

We would like to acknowledge the generous participation of the interaction designers in this research. This study was conducted in the National Design Centre, UiTM. Fully appreciate to Malaysia Ministry of Higher Education for the financial support under FRGS grant with a Sponsorship Grant No. FRGS/1/2019/SSI07/UiTM/02/8 and registered under UiTM Research Management Centre File No.600-IRMI/FRGS 5/3 (463/2019). Our heartfelt appreciation also goes to the Multimedia University (MMU) for their support under the Human Resource Development Fund (HRDF).

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