THE ROLE OF CULTURAL SCHEMA IN DEVELOPING CULTURE-BASED PRODUCT DESIGN

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Abstract: Culture is an important aspect to consider when designing a product, both as an inspiration and influence in the cognitive process of design. The cultural backgrounds of users and designers should be taken into account in the context of cognitive processing. Cultural schema refers to culture at the cognitive level, which provides references in the form of knowledge while also shaping perspectives. This study explores the role of cultural schema in culture-based product design by attempting to identify the opportunities and constraints posed by culture. Examples were drawn to explain about cultural schema role in designing products based on cultural artifacts that suggest design context interacted with cultural schema in design process that results in different interpretation of design from the same cultural artifact.

Keywords: culture, schema, design, opportunities, constraints

1. Introduction

In recent times, the borders between cultures have become blurred as a result of globalization, creating a multicultural world [1]. On the other hand, globalization has also produced a new awareness of local culture in an effort to preserve cultural values and identity. Given the need to express one’s identity—which includes local identity and its relationship to culture—there has been a revival of culture and tradition [2]. The trend toward culture-based design is manifest in the localization and “glocalization” movements. Localization aims to develop a design for the culture it originates from while glocalization aims to develop a culture-based design for the global market [3].

Culture provides rich sources of references, inspiration, and opportunity in developing designs. At the same time, culture can also impose constraints on how the design is perceived. Cultural beliefs, values, and social practices frame the way people relate to an object [4]. Different users with different cultural backgrounds can relate differently to the perceived function of the same object. On the other hand, the designer’s cultural background also influences design development. This is evident in the development of design styles based on the cultural group from which the design originated (e.g., Japanese design and Scandinavian design). Such styles can be evident even in designs that are not explicitly inspired by culture.

The creative process of design always occurs on the basis of some amount of prior knowledge [5]. The amount of prior knowledge referenced in the design process determines the novelty of the resulting design, whether the design is an imitation, modification, or innovation. Prior knowledge itself is interrelated with the culture to which the designer belongs. The retrieval of prior knowledge is a cognition process that involves schema processing.

The challenge of culture-based product design lies in understanding the opportunities and constraints presented by culture. Identifying these opportunities and constraints is an important part of the creative process, and such identification can be performed by investigating the schema in the context of culture. In turn, the information will be beneficial to understand the influence posed by culture to design development.

Schema refers to the structure of prior knowledge and the cognitive process of interpreting information [5][6][7][8]. In the context of culture, cultural schema is the structure of prior knowledge shared by the population of a cultural group [9]. The content of schema includes...
various types of knowledge—both abstract and concrete—consisting of information, images, ideas, scenarios, and so forth. In the context of culture, the knowledge structured inside a schema relates to a cultural group’s way of life. Such knowledge is particular to the cultural group and is shared by its members, defining its cultural schema.

This study examines the role of cultural schema in the creative process of designing a culture-based product, based on the assumption that cognitive processes, including creative processes, are influenced by culture as a cognitive attribute [10]. The cognition process in designing a product involves the activation of various schemata, including cultural schema as prior knowledge that acts as a reference. The reference of prior knowledge is then identified in terms of opportunities and constraints to be either encouraged or overcome in the effort to develop a new design.

2. Objectives

Culture and design, particularly design strategy in developing culture-based and culture-oriented design was widely studied. The studies are mainly focusing on transformation and application of cultural knowledge to design [4][11][12]. On the other hand, it is apparent that culture possess important role on human cognitive and perception [13]. One theory that explains culture in cognitive level is schema theory, specifically cultural schema theory. However, cultural schema and its application in design have not widely studied [5].

In light of recent development in design field where new designs are created with culture as inspiration, the study of cultural schema and its application in design become more relevant. While it could be argued that the possession of cultural knowledge is enough to develop a culture-based design, one should take into account the cognitive process of cultural schema that influence designer’s and user’ perception. It is widely accepted that culture in form of cultural schema is a major force in the process of perceiving and interpreting stimuli, and in turn producing meaning [5]. Therefore, it was hypothesized that since cultural schema shapes perception and guides interpretation, cultural schema posed both opportunity and constraint in production of meaning. Cultural schema is not only consist of cultural knowledge that serves as reference and inspiration in designing a culture-based design, but also the constraints posed by the cultural-specific perception and behavior.

This study attempts to explain the role of schema, particularly cultural schema in developing culture-based design by developing framework of identification of the opportunities and constraints that posed by culture. It was hoped that this study be a meaningful contribution in the field of design psychology.

3. Method

The method used in this study is literature review. Literature sources that contribute to this study encompass three main topics. The topics are cultural psychology, cognitive psychology, and design.

The topics discussed in this study are how schema work and its application in product design, culture and cognition, cultural schema and its application in design, and framework of culture-based design process with schema theory approach. The understanding on culture and cognition in general is imperative to understand the more specific theme of cultural schema. In turn, understanding on how schema works and how it could be applied to design is necessary to understand how cultural schema works and applied in design.

Examples of application of schema and cultural schema in product design are discussed to aid the understanding.

4. Schema Theory

Bartlett defines schema as an organized structure of past knowledge, experiences, and expectations regarding certain aspects of the world [6]. In other words, schema refers to structures of knowledge that consist of information (objects, events, behavior, images, etc.) and the relationships between each part, which act as references to interpret new information [7][8]. The content of schema can vary by individual, depending on the individual’s knowledge and experience. Schemata represent knowledge on all levels, from abstract to concrete. The schema concept can be applied to both abstract concepts (e.g., justice and faith) and very concrete things (e.g., visual appearance) [14].

Schema plays an important role in processing the interaction between old knowledge (old information from a generic schema) and new knowledge (episodic input) to make sense of information. It refers to unconscious cognitive structures and processes that guide knowledge and skill, a cognitive shortcut for interpreting and perceiving. The human mind constantly draws partial inferences from incomplete information by fitting new information (episodic input) into the existing schema (generic schema). The cognitive processing of schema is largely unconscious and automatic [8].

![Figure 1. Schema processing model; adapted from Brewer and Nakamura [15]](image)

According to Brewer and Nakamura, schema-based information processing involves three elements: generic
schema, episodic input, and instantiated schema. Generic schema is schema that contains fixed structural content (knowledge, skills, relations, behavior, etc.) as well as slots to accommodate new information input. The input comes from episodic input, which is information collected from the environment during exposure to stimuli. The interaction between generic schema and episodic input results in instantiated schema. Instantiated schema that is repeated is stored in the long-term memory, eventually becoming generic schema, which is easier to recall. Without repetition as reinforcement, however, instantiated schema stored in the short term memory will be discarded. The experience and knowledge structure of a schema is a reference point for information processing. New information is processed by trying to fit it into the existing schema. Information that fits the schema is processed faster and reinforces the validity of the schema, thus strengthening the schema and leading to better memory [15]. For information that does not fit the existing schema, three outcomes are possible: 1) the schema is modified to include the new information, 2) the information is modified to fit the schema, or 3) the information is discarded as nonsensical [16].

Hurtienne and Blessing [17] developed a model to describe the hierarchy of knowledge in human minds based on the frequency of encoding and retrieval of knowledge. The encoding and retrieval of knowledge are inseparable from the concept of schema since knowledge itself is the content of the schema.

![Encoding and retrieval](image)

**Figure 1. Schema processing model; adapted from Brewer and Nakamura [15].**

The nature of schema theory is broad in its application, from abstract concepts such as faith and justice to more concrete ones such as written law. As such, the field of design also benefits from the application of schema theory. Schema theory in design refer to design based on existing knowledge, intuition, and automatic responses of the user, which are the schemata itself. The use of schema theory in design enables user to understand and react to the object quickly and accordingly, which contributes to better usability. Several examples of the application of schema theory in product design are discussed in the next section.

### 4.1. Application of schema theory in design

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#### 4.1.1. Image schema

An example of the application of image schema to intuitive design in the sensorimotor level is the schema of space. One representation of space schema is direction (e.g., UP and DOWN, LEFT and RIGHT, FRONT and BACK). The UP and DOWN/LEFT and RIGHT schema has been used extensively in designing aspects of products [17] (e.g., volume buttons on cellular phones). The familiarity of the schema stems from metaphors related to beliefs that translated into directions.

Metaphor of UP and DOWN were associated with spiritual belief where UP refers to high places where believed as the residence of Gods, thus the positive association, and DOWN refers to below the earth where it was believed the devil resides, thus the negative association (e.g. Semitic religions where heaven is alluded to reside in the sky; Greek culture where Mount Olympus was believed to be residence of Gods, and below earth was believed to be where hell resides; Indonesian native spiritual concept where Gods were believed to resides in mountains such as Mount Mahameru.).

The metaphor of UP as positive/increase and DOWN as negative/decrease translates into the directions of the button. The iPhone 6 has two volume buttons: an upper button (UP) for increasing volume and a lower button (DOWN) for decreasing volume. The positioning and elevated surface of the buttons make it possible to rely on touch to adjust the volume. Directional metaphor was also applied to the digital representation of volume adjustment, with LEFT representing negative/decrease and RIGHT representing...
positive/increase. The metaphor stems from the belief that RIGHT considered good that originates from the occurrence of right hand as dominant hand in majority of population, thus regarded as the “good” hand that contributes to the positive association, and vice versa for the left hand.

4.1.2. Visual image schema

Visual representations of various objects, situations, and ideas are included in the knowledge structure that constructs a schema. The image association concept is widely used in product design. UX designers, for example, employ image association in user interface design. Figure 4 shows the user interface of an iPhone. The displayed icons correspond to their use. Specifically, the flashlight, clock, calculator, and camera icons correspond to their respective functions: a source of light, time (show time, alarm, timer, stopwatch), number calculation, and picture taking. These icons are based on physical objects that are part of the schema of activities related to the objects, manifested in graphic representations of those objects associated with their functions. Such association activates the schema for understanding the functions represented by the icons.

Figure 4. Example of image association in packaging design [19].

Figure 5 shows packaging designs for fruit-flavored drinks that use image association. The shape, color, and graphic design of the packaging represent fruits that are associated with the flavor of the drink inside. The fruit schema content includes the shape, color, and flavor of the fruit. Designing the packaging based on the visual appearance of the fruit activates the fruit schema and gives information —based on previous knowledge regarding the represented fruit—about the drink’s flavor. For the user, fruit-schema activation also triggers affective responses (like/dislike) in relation to the fruit, prompting the user to act accordingly (buy/not buy).

4.1.3. Affordance

Affordance appeals to sensorimotor intuition. Affordance in the context of schema theory application refers to perceived affordance [20] rather than real affordance [21]. Real affordance refers to all possible uses of an object independent of the user perception [21]. Perceived affordance involves the process of sense-making by the user [20]. The process of sense-making involves schema activation. Regarding perceived affordance, activated schemata are related to logic and intuition in the context of usability. In the design context, designers should provide signifiers to indicate the affordance of an object [20].

Figure 6 shows two different approaches to a door handle that appeal to the user’s intuition regarding how to operate the handle. The door handle acts as signifiers directive on the door handle’s usability. The flat panel signifies operation by pushing. In contrast, the vertical bar signifies a pulling operation. The acts of pushing and pulling are intuitive in relation to the signifiers. The flat panel leaves no room for an interpretation other than pushing since other operations are physically impossible. Meanwhile, the vertical bar indicates the possibility of operation by gripping and pulling based on the shape and direction of the bar’s protrusion.

5. The Cognition of Culture and Cultural Schemata

Culture and cognition are interdependent. While cognitive psychology focuses on individual minds and behaviors, individuals belong to groups/populations. As such, a large part of an individual’s cognitive activity is directed toward other individuals of the same group/population as they interact. Individual cognitive activity manifests in such forms as conversation, media messages, and material culture [8]. Thus, cognitive activity is the main factor in the formation of sociality and culture [16]. On the other hand, phenomena occurring in groups/populations influence the development and application of individual cognition. Culture is constantly modified through cognitive processes of its cultural group members, while its members absorb culture through learning and enculturation process. In other words, culture is the effect and manifestation of human cognitive ability.

Contemporary human societies culturally frame every aspect of human life, especially cognitive activity. Thus,
cognitive ability and activity are undoubtedly related to human psychological states [16][23][24]. Cultural variation is the effect of similarities in the biological element of humans—especially their cognitive abilities, which evolved differently as a result of different historical and ecological conditions [16]. Across populations, there are differences in social, political, and economic circumstances, which create variation in the content of human minds (theories, values, beliefs) [24].

Culture is the sum of mental representations, their public expressions, and resultant behaviors in certain contexts, which are always in continuous interaction with each other [5]. Culture encompasses mental, behavioral, and physical realms [5][25][26], which can be further described in terms of three levels of the spatial dimensions of culture: the inner level, which consists of values, beliefs, preferences, and other psychological attributes; the intermediate level, which consists of behaviors, activities, and languages; and the outer level, which consists of objects, materials, and artifacts [25][26]. The intermediate and outer levels express the inner level in the physical world. One’s behavior (intermediate level) is the expression of values, norms, beliefs, etc., that are internalized at the inner level. Various tools and artifacts (outer level) are created to facilitate human needs (inner level) and activities (intermediate level). Since the levels are dynamic and influence each other, the relationships among them are reciprocal.

**Figure 6. Three levels of the spatial dimension of culture [25]**

### 5.1. Cultural Schema

From the overview of culture as cognitive attribute, it could be inferred that culture in cognitive level exists as structures of schemata that resides in inner level of the spatial dimension of culture [25]. Referring to the spatial dimension of culture, attributes that resides in intermediate level and outer level are representations and expressions of cultural schema.

Schema theory functions as a bridge between theories of culture and psychology [16]. Culture itself is interdependent with schema since schema formation results from cognitive activity involving interactions with physical and social environments in the culture one belongs to. On a larger scale, above individual schema, there is cultural schema, which works at the social or cultural level. Some similarities across populations in a society can be attributed to cultural schema.

Cultural schema refers to thematized, widely shared schemata, and it is the smallest unit of culture that can be analyzed [8]. Furthermore, cultural schemata are defined as patterns of basic schemata that construct the meaning system of a cultural group [27]. In principle, cultural schema and individual schema do not differ, except that cultural schemata are shared by certain groups instead of individuals [9]. Cultural schema contributes to cultural bias, stereotypes, and prejudice due to its shared characteristics.

At the individual level, culture is shaped by the internalization of social activity through learning processes. Arguably, internalization and learning processes occur through repeated experience and exposure to cultural elements (e.g., social environment, objects, language, beliefs, values). Repeated experience forms a generic structure in an individual’s mind [15] and becomes a subconscious knowledge schema through frequent encoding and retrieval processes [17]. Culture as cognitive attribute in an individual’s mind is schemata consisting of various images, behaviors, and information acquired through sociocultural interaction and environments. In turn, the cultural schemata guide the individual perception and behavior.

The “sharedness” of schema is the defining characteristic that categorizes a schema as cultural schema [28]. Though not all schemata in one’s cognition are cultural, a large part are. In terms of sharedness, schemata could be recognized by three categories: a universal schema is shared across the human population, consisting of innate knowledge (see Figure 2) [17] that develops regardless of culture and experience. Thus, universal schema is the most widely shared. Meanwhile, cultural schema is subject to culture-specific experiences and is thus shared specifically among the members of a cultural group. Individual schema is subject to individual experiences and is thus more detailed and personalized. Conversely, individual schema is highly variable while cultural schema is more general, and universal schema has low variability.

Shore [29] classifies cultural schema into two categories: externalized schema, which is the public representation of schema in the form of cultural artifacts, and internalized schema, which refers to cognitive representations of externalized schema. These two categories constantly interact with and modify each other. This concept is similar to the spatial dimension of culture theory proposed by Siu [25] and Ardila [26] (see Figure 2). However, in Shore’s classification of cultural schema, intermediate-level variables are included as externalized schema since they express internalized schema. In the context of cultural schema and its role in design, the spatial dimension of culture theory is more appropriate in consideration of the three levels of design features: visceral, behavioral, and reflective [30].

Cultural schema should not be confused with cultural knowledge. Cultural knowledge is a part of cultural schema that also includes culture-specific perception. The activation of cultural schema is interdependent with the context of the stimuli [31]. The nature of schema is largely unconscious [6] and therefore difficult to investigate. However, investigation can be attempted via schema activation in response to stimuli corresponding to the three levels of the
spatial dimension of culture (inner, intermediate, and outer; see Figure 6) [25].

According to the discussion, it could be inferred that cultural schema possess several characteristics unique compared to the individual schema: cultural schema is specific to a cultural group and shared among the members of those cultural group. However, since environment plays an important role in shaping culture, it is possible that similar schemata could form in different cultural groups due to similarities in environment.

5.2. Cultural schema in the product design context

Cognitive process between different cultures can vary in the procedures the mind uses to solve an otherwise typical problem. The existence of artifacts with various designs is one result of cognitive activity attempting to solve problems. For example, seating facilities ranging from short stools to dining chairs were created to solve problems related to human activity. A short stool enables the user to be more comfortable in an activity requiring the user to squat for a prolonged time. Meanwhile, a dining chair enables the user to be more comfortable during extended meals. Theoretically, meals are not necessarily extended periods, but some cultures perceive mealtime as a time to socialize (e.g., European culture); thus, the meal experience needs to be pleasant and comfortable. One effort toward making the meal experience pleasant and comfortable was the design of dining chairs with added features, such as cushioned seats and backrests.

Through its system of representation, culture is fundamental in the production and reception of meaning [5]. Representation manifests in both tangible and intangible ways. Tangible representations of culture are the physical objects or tools that aid human life. In the context of product design, products that contain embedded cultural content are considered cultural artifacts. Cultural artifacts are part of the outer level of culture (see Figure 6) [25]. Cultural artifacts are inseparable from the cognitive process of activating cultural schema in their production and interpretation.

![Figure 7. Cognitive process of the interpretation and production of cultural artifacts [5]](image)

Figure 7 illustrate the cognitive process of interpretation and production of cultural artifacts. Interpretation and production of cultural artifact involve activation of schema as interaction of cognition (thinking) and cultural knowledge. The interpretation of cultural artifacts involves a process of analysis and understanding by the user. The interpretation process refers to prior knowledge in the form of cultural knowledge that activates schemata related to the cultural artifact. The cultural artifact production process also refers to cultural knowledge in creating the cultural artifact by activating the appropriate schema. Cultural artifact production is practiced by designers and involves design and creative processes [5]. However, it is important to note that in the process of developing new design based on cultural artifact, interpretation also plays a role in deciphering attributes of cultural artifact that applicable to the production of new design. Thus, in context of developing design based on cultural artifact the process of interpretation and production are not mutually exclusive, rather it is a chain of process.

a. Examples: production of cultural artifact

Siu [25] provides examples of how culture affects the design of objects and materials based on the spatial theory of culture (Figure 6). Siu uses the example of Chinese eating culture and its manifestation in objects surrounding the eating activity. As a culture that holds the family in high regard, the activity of families having meals together is an important part of daily life (inner level). The importance of having meals together increases on special occasions such as festival days and new-year celebrations. The importance of togetherness manifests in the act of sharing meals placed in the center of the table (intermediate level, behavior). In turn, the culture of sharing meals placed in the center of the table manifests in the round design of dinner tables (outer level, objects). Round tables with rotating centers—which make it easier for family members to share meals—are also popular [25].

The production of round dining table with rotating center was a result of schema activation in terms of “eating” schema of Chinese culture that involves a structure consisted of “togetherness” and “behavior of sharing meals”. Such designs differ, for example, from the preferences of European cultures, which tend to favor rectangular tables. Other examples can be drawn regarding the use dining room chairs in Chinese and European cultures, and the absence of chairs in Japanese and Korean cultures [32].

![Figure 8. Zaisu: legless chairs resulting from Japanese floor-sitting culture [33]](image)

Floor-sitting culture is prevalent in Japanese and Korean culture [32]. The sitting schema for Japan and Korea differs from other cultures in that sitting in formal setting does not necessarily require a chair. A chair in this context is a legged tool that supports human weight in the act of sitting. However, this culture does not stop the production of a cultural artifact that facilitates more comfortable floor-sitting behavior in the form of zaisu (Figure 8). Zaisu is an interpretation of a chair in the context of floor-sitting behavior in Japanese culture, manifested as a legless seat with back support [34].

As a comparison, Indonesia have similar floor-sitting culture “ilesehan” that does not produced artifact similar to
Thus it could be inferred that the production of zaisu is culture specific to Japanese and Korean culture. However, zaisu was widely adopted in Indonesia due to the similarity of the sitting culture. The adaptation of zaisu is not exclusive to cultures with similar sitting culture, but widely adapted in interior design due to the popularity of Japanese aesthetics.

Figure 9. Kobokan: a handwashing bowl [35]

b. Example: interpretation of cultural artifact

Figure 9 shows a small bowl. Small bowls are generally perceived as containers for liquids such as soup. However, in Indonesian culture, such a bowl activates a culture-specific schema where the bowl’s perceived function is to wash one’s hands before eating (kobokan). There are widely reported anecdotes about people unfamiliar with Indonesian culture drinking the water in a kobokan. This cultural schema stems from the Indonesian cultural practice of eating with one’s hands. In this example, an eating habit specific to Indonesia is a cultural schema whose content includes using a small bowl as a handwashing tool. Cultures with the eating habit that utilize tools such as spoon, fork, knife and chopstick have no schema of handwashing bowl. In turn, Indonesians adopting tools in dining, but the use of handwashing bowl persist as cultural schema that activated in interpretation process when users are faced with a small bowl with clear water along with a meal. It could be inferred that the use of a small bowl can vary depending on the user’s perception. In this case, the differing variable of perception is culture since culture influences how humans perceive the world and make inferences.

5.3. Cultural artifact as a reference in the design process

Cultural artifacts also serve as references in designing culture-based products. Using a cultural artifact as a reference involves processes of both interpretation and production as illustrated in figure 7. Cultural schema as prior knowledge acts as a point of reference in the product design process[5].

The process of designing a product with a cultural artifact as a reference first involves interpretation through the activation of schemas. The result is that information about the cultural artifact regarding its visual, behavioral, and symbolic value is referenced in the production of a new cultural artifact. The interpretation process provides information regarding the constraints and opportunities posed by culture in relation to the artifact. In the process of producing a cultural artifact, the information resulting from the interpretation process undergoes transformation, elaboration, and rejection [5]. Corresponding to the process shown in Figure 2, the interaction between cultural schema in the form of information resulting from the activation of schemata in the interpretation process as generic schema and new information in the form of design problems results in instantiated schema in the form of information of opportunities and constraints which would be applied to develop new design.

Figure 10. Design process using a cultural artifact as a reference.

The examples discussed in this chapter is the interpretation of a cultural artifact that is pincuk that resulted in inspiration to design new products. Pincuk is a food container made from banana leaves that widely used in Indonesia. The wide and flat banana leaves is folded to form conical shape and held together by wooden or bamboo stick. Pincuk is used primarily as container in street foods due the cheap material (banana leaves) and its conical shape that provides easiness of use to be take-away food container. The attributes of pincuk was identified according to the three levels of design: visceral (visual attractiveness), behavioral (usability and experience) and reflective (image and symbol) [30]. In visceral level, the visual attributes of pincuk are identified as shape (conical), texture (raised parallel lines of banana leaves), and color (green of banana leaves). In behavioral level, the attributes are identified as the usability (held in palm of hand) and experience (take-away eating experience). Reflective level attributes are the image (cheap, due to association in street food) and symbol (sustainability due to the use of banana leaves, a sustainable material).

Figure 11. Pincuk: traditional Indonesian food container [36]

Cultural schema plays a part in these identification
particularly in perception of banana leaves as material. Banana leaves is ubiquitous in Indonesia and traditionally used in various food packaging. The abundance of banana leaves contributes to its low price, thus banana leaves is widely used in the presentation of street food. The association with street food impacts the image of banana leaves as cheap, thus correlates with the cheap image of pincuk. The perception of banana leaves as cheap is not necessarily shared by the member of other cultures, for example Western cultures where banana plants are scarce, thus banana leaves is perceived as exotic.

The attributes of pincuk that was identified in reflective, behavioral, and reflective levels are the source of inspiration in designing new product as described in the following examples. In visceral level, Figure 12 shows a tableware set that identified the pincuk aesthetic as an opportunity for design application in the production process (elaboration) in form of color and texture that mimics banana leaves; In behavioral level, pincuk usability, however, was considered a constraint (rejection). The usability of pincuk where pincuk was to be held in palm of hand is rejected, thus the conical shape was modified to accommodate more conventional setting where the bowls is placed in table surface. In reflective level, the symbolic value of sustainability was retained by using ceramic material, which is also considered sustainable, while rejecting the image of cheapness by using ceramics instead banana leaves that associated with cheap street food, thus elevating the product image (transformation). While the color and texture of banana leaves was considered an opportunity, the association of cheapness in actual banana leaves was considered a constraint. In contrast, Figure 13 shows a tableware set that identified pincuk’s usability as an opportunity—aside from its aesthetic (conical shape) and symbolic value (sustainability)—by using sustainable laminated bamboo [37].

Figure 14 illustrates the process of interpretation of pincuk in two context that resulted in two different product outcomes. These two different product outcomes showed the schema processing involved in the production process, where cultural schema interacts with new information in the form of a design problem. The tableware shown in Figure 13 was created by Jenggala [37], a renowned Bali-based company that markets its products globally. It can be inferred that in designing a product that could be marketed globally, the cultural schema-specific usability of pincuk was considered a constraint; thus, the shape was modified for more general usability. The tableware shown in Figure 13, however, experimented with using laminated bamboo as material, while also promoting the traditional usability of pincuk as part of a cultural conservation effort [38]. These two examples suggest that despite using the same cultural artifact for reference (generic schema), new information in the form of design problems and intention (episodic input) resulting in different perceived opportunities and constraints (instantiated schema), which in turn can affect the design production process, thus resulting in different product designs or new cultural artifacts.

6. Identifying Opportunities and Constraints in the Cultural Schema

Cultural schema reinforces stereotypes and prejudice, and can hinder organic thinking [31]. While an understanding of cultural schema is beneficial for designing culture-based products by providing information about how users interpret artifacts, references in terms of behavior, visual preferences, symbolic values, etc., are also beneficial for identifying constraints posed by cultural schema.

As illustrated by the different perceived functions of the small Indonesian bowl (kobokan; Figure 9), cultural schema can pose a constraint in terms of how to perceive affordance.
The same constraint is not limited to affordance. As shown in Figure 2, sensorimotor and cultural knowledge exist on different levels. According to the model, affordance exists on the sensorimotor level. However, it was argued that affordance is subject to culture [20]. Schemata within the continuum of knowledge can influence each other across levels.

In designing a culture-based product, the two aspects of cognitive processing (interpretation and production) in schema activation regarding the cultural artifact are inseparable. The processing involved in interpretation and production activates schemata that give insight into the opportunities and constraints posed by the cultural schema. Opportunities and constraints are perceived differently in the context of new information in the form of the design problem and the design intention.

Figure 15. Identification framework for opportunities and constraints.

Figure 7 shows the design process using a cultural artifact as a reference, where the artifact is interpreted and the resulting information is used as a basis for designing a new artifact. However, culture encompasses not only artifacts (outer level) but also behavior, language, and tradition (intermediate level), as well as values, beliefs, and preferences (inner level) (Figure 6) [25]. These three levels contain cultural schemata that are potential sources of inspiration for culture-based design. Therefore, a more generalized framework for identifying opportunities and constraints based on schema processing theory is needed to accommodate references other than cultural artifacts. Such a framework is developed based on the three-variables model of schema processing (i.e., generic schema, episodic input, and instantiated schema) and the cognitive processes involved [15].

Figure 15 shows that identifying the opportunities and constraints posed by culture occurs through the activation of schema in the interaction between information derived from interpreting a cultural artifact and new information/stimuli. This process is parallel to the schema processing model shown in Figure 1. The cognitive processes involved in schema processing in Figure 2 are approval, modification (of schema or information), and rejection. The model in Figure 15, where approval is parallel with elaboration and modification is parallel with transformation and rejection, has the same mechanism as the model in Figure 1.

In the framework, cultural schema acts as generic schema while episodic input represents stimuli related to the design process. The interaction between cultural schema and stimuli activates schemata that result in instantiated schema in the form of opportunities and constraints. Instantiated schema is dependent on the interaction between generic schema and episodic input. Thus, the opportunities and constraints posed by cultural schema are subject to the context of the design process, even though the cultural schema itself is constant.

The framework illustrated in figure 15 resulted in instantiated schema in form of information of opportunities and constraints posed by cultural schema. These information is to be applied to design process which involve synthesis and appropriation[5] of the information to produce new design features (Figure 10). The identification of opportunities and constraints posed by cultural schema in context of the design problem and intention could provide more insight on designing new design that effective, efficient and incited satisfaction on its user.

7. Conclusion
Culture encompasses the cognitive, behavioral, and physical realms. By definition, cultural schema resides in the cognitive realm but is expressed through behaviors and material objects and artifacts. In turn, interaction with the world—including social behavior and material interaction—modifies cultural schema. Opportunities and constraints posed by culture are investigated by activating cultural schema through exposure to stimuli. Identifying opportunities and constraints is vital for transforming culture into design. Information regarding opportunities should be applied in design while constraints should be overcome.

This study attempted to explain the cognitive processes involved in designing a culture-based product by examining the interpretation and production of cultural artifacts. Based on the interpretation and production of a cultural artifact through the activation of schema, a framework was constructed in an attempt to identifying the opportunities and constraints posed by culture. The framework was constructed in accordance with schema processing using three variables: generic schema, episodic input, and instantiated schema. Future studies should test the ease and efficacy of identifying the opportunities and constraints posed by cultural schema by conducting experiments based on the framework.

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