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PROPOSING A NEW PRODUCT CREATIVITY ASSESSMENT TOOL AND A NOVEL METHODOLOGY TO INVESTIGATE THE EFFECTS OF DIFFERENT TYPES OF PRODUCT FUNCTIONALITY ON THE UNDERLYING STRUCTURE OF FACTOR ANALYSIS

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Abstract

The aim of study is to indicate a gap in creativity research arising from products with dissimilar capabilities requiring independent creativity indicators that are empirically formed according to their functionality. Initially, a hypothesis for a criterion-based tool comprising 9 criteria and 40 indicators is put forward for assessing functional products. Then, a novel experimental approach is presented to indicate this variation. The first experiment uses the Consensual Assessment Technique (CAT) to measure the product creativity as well as the relationship between creativity and the criteria proposed. Then, EFA is considered to extract the irrelevant items and provide the optimum underlying structures for the factors used in each assessment. The validity of the models will then be investigated using the comparison of the goodness of fit indices between the estimated factor loadings calculated by CFA measurement and the empirical data collected from the second study. It is anticipated that the findings of this experiment will result in three dissimilar tools, where each comprised of specific indicators that appropriately established with respect to various product functionality.

Keywords: Creativity, Evaluation, Innovation, Research methodologies and methods

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1 INTRODUCTION AND BACKGROUND

Creativity is consistently interpreted using the two attributes of *novelty* and *effectiveness* (Gardner, 1989; Runco and Jaeger, 2012; Childs et al., 2006). This can be classed in terms of four facets known as the 4P's of creativity: the *person* (or trait), *cognitive process*, *place* (or environment), and *product* (Couger, 1996; Sawyer, 2006; Kozbelt et al., 2010). Research on creativity began systematically in the 1950s and since then many scholars have set out to understand its characteristics. Measurement of creativity using the 4Ps as a guide has been regularly employed by researchers, with measuring a product's creativity an essential element (e.g. Plucker and Makel, 2010). Evaluation in this context, is performed independently of the people, thinking styles, and environment that are all commonly employed in a design process. In other words, creativity is detectable when an adequate number of appropriately experienced people can observe the related characteristics at a glance, without considering the actual design process (Amabile, 1996). This statement is in agreement with the "gold standard" of creativity measurement known as Consensual Assessment Technique (CAT) (Carson, 2006; Sternberg and Lubart, 1999). Amabile (1982) established this technique based on the concept of *independent judgment*. Amabile believed that a highly creative solution is recognisable when a sufficient number of experts can independently perceive similar levels of creativity. The main reason for using professionals is because they employ their own subjective criteria for the evaluation of creativity, and are capable of achieving a high degree of consistency among their peers.

The CAT has been employed to measure the creativity of artworks such as poems, music, stories, and films (e.g., Amabile, 1982, 1983; Baer et al., 2004; Kaufman et al., 2008). For instance, Kaufman et al. (2007) examined the creativity level of 12 black and white photographs, using 4 graduate students (as judges) with 81 undergraduate students (as participants) generating captions for each picture. The resulting inter-rater reliability (Cronbach's alpha) indicated that the CAT is a reliable and valid measurement tool for expert assessments of creativity. In another study, Kaufman et al. (2008), investigated the validity of exchanging experts with non-experts for the case of poems. In their study, 205 college students were asked to write a poem that was later judged by two groups of raters, including (a) 10 experts and (b) 106 novices. After standardising the result of the reliability test (alpha) using the Spearman-Brown formula, they reported a significant difference (r=.23) between the values of Cronbach's alpha, which revealed the inconsistency among the non-experts (.804 for experts and .575 for non-experts). These two studies led, among other findings, to a conclusion that two criteria are important in determining the outcomes of the CAT: (a) product type, and (b) the judge's experience (Hickey, 2001; Kaufman et al., 2010). Likewise, one can argue that for the assessment of more complex engineering products, an adequate level of expertise is required (Kaufman et al., 2013).

Consensual assessment of creativity is known to be very useful and reliable approach, even though it is not the only measurement tool available. According to O'Quin and Besemer (1999), three main categories of measuring product creativity are: (a) indirect measurement; (b) global-judgment, and; (c) criterion-based models. Indirect and global-judgements are not bound by a specific definition for creativity, and the entire process is implemented using the judge's opinion (Horn et al., 2006a). Another measurement approach is to decompose the product into attributes that contribute to creativity and instead replace the experts with non-experts (Besemer and O'Quin, 1986, 1987). The same authors, later developed the Creative Product Analysis Matrix (CPAM) consisting of three dimensions to evaluate product creativity (novelty, resolution, elaboration and synthesis). This model uses 9 sub-items to describe the main dimensions from different perspectives (Besemer, 1998). For example, surprisingness and originality for *novelty*, usefulness, logical, understandability, and value for *resolution*, and organic, well-craftedness, and elegance for *elaboration and synthesis*.

In an extensive study, Besemer and O'Quin (1986) proposed and validated the Creative Product Semantic Scale (CPSS) based upon their previous model (i.e. CPAM). Their new instrument utilised a 7-point bipolar adjective system for scaling, and is composed of 55 items that have been structured into 11 sub-factors and 3 criteria similar to CPAM (novelty, resolution, elaboration and synthesis). A number of studies have examined the applicability and validity of the two models (Besemer et al., 1999; O'Quin et al. 2006; White et al. 2001). One of the earliest attempts was undertaken by Besemer and O'Quin

(1986), assessing the creativity of two T-shirts using 70 items and 133 students. They reported the usefulness of CPSS to product designers and suggested that 10-15 items can be eliminated without significant changes to reliability.

O'Quin et al. (1989) examined the ability of CPSS to determine the various aspects of *novelty* using 194 students and three decorative products. They confirmed the detection of *novelty* applying the original indicators of CPSS, while the results of principal component analysis (PCA) from their second study showed that the *novelty* and *resolution* together could describe 65% of the total variances. Likewise, the outcomes of Multivariate Analysis of the Variance (MANOVA) also demonstrated that sub-factors such as originality, surprising, and elegant could also describe most of the variances. In line with this, Besemer (1998), investigated the factor structure of CPSS using Exploratory Factor Analysis (EFA) along with Confirmatory Factor Analysis (CFA) for the final validation. According to the results from CFA evaluation, a factor structure with 3 criteria achieved a better goodness of fit than the solution with two factors.

In evaluating product creativity through criterion-based models, other researchers have also contributed different points of view. Cropley and Cropley (2008) suggested a hierarchy of product creativity in which the most important aspect of a product is to present some effectiveness to the consumer. Their investigation led to the generation of a powerful assessment tool (the Creative Solution Diagnosis Scale, or CSDS) consisting of five criteria: (a) relevance and effectiveness; (b) problematization; (c) propulsion; (d) elegance, and; (e) genesis. Initially, this tool comprised a four-factor, 30 indicator scale of product creativity. However, two studies (Cropley et al., 2011; Cropley and Kaufman, 2012) used factor analysis to refine this to the current five-factor structure. One of the distinguishing features of CSDS is the emphasis in describing creativity using indicators beyond *novelty* and *effectiveness*. In other words, they believed that creative products must solve dissimilar problems, and offer alternative perspectives to observe the subject, while adequate levels of novelty and effectiveness are still essential for the assessment.

The validity of CSDS remained unknown until Cropley et al. (2011) further refined and validated the tool with 323 college students evaluating five mousetraps. According to their CFA test, three items were eliminated (i.e. replication, incrementation, combination) which either cross-loaded at less than 0.3, or did not been load onto any factor. Later, Cropley et al. (2012) performed further experiments and removed another 3 elements which reduced the number of items to a total of 24 indicators. This reduction has provided them with an excellent value of 0.95 for alpha (internal consistency), whereas their CFA assessment has confirmed the same five-factor structure.

In the meantime, Horn et al. (2009) conducted several experiments based upon consumer perception of product creativity. Initially, two types of household products (chairs and lamps) were employed and given to 208 students to find out the correlation between product creativity, customer satisfaction, and purchase intention. Then, another group of participants (108 students) were asked to rank the same indicators of product creativity as well as the customer attitudes on several individually selected products. The result of their investigation has led to the establishment of a tool comprised of 3 criteria and 13 sub-criteria known as product creativity measurement instrument (PCMI). In total, they have conducted 4 EFA, utilising both Varimax and Promax rotation systems, resulting in three factors including *affect*, *novelty*, and *importance*. After eliminating insignificant items, they reported that nearly 71% of the total variances of the chairs, 75% of the lamps, 70% of the combined data, and 73% of the individually selected products were able to be explained using the PCMI structure.

In summary, product creativity is currently being assessed using either subjective tools (e.g. CAT) or criterion-based approaches (e.g. CPAM, CSDS). For subjective methods, a reliable result depends on the appropriate selection of competing products and the experience of the judges. Whereas, the relatively high cost and time of this approach have allowed the criterion-based model to play an important role. However, the design of a criterion-based model is involved, with elements where their appropriate selection and implementation can significantly alter the outcomes. In the literature, less attention has been given to this important aspect of product creativity assessment. For instance, it is clear that different participants can rate disparately, whereas different product functionality can receive distinctive opinions. In other words, different features mentioned above as the input to a factor analysis test can directly alter the final structure and the items of the outgoing product creativity model.

In this project, a criterion-based assessment model has been proposed where the measurement domain is restricted mostly to functional products. Lindstrom et al. (2012) defined a functional product as one integrated system composed of hardware, software, and a service support system. The aim of the project is to investigate the effects of different types of products on identifying the underlying structure and relationship among the factors when determining product creativity indicators using factor analysis.

2 PROPOSING A NEW CRITERION-BASED MODEL

In this research, the proposed model follows the criterion-based approach, while the assessment domain is mostly restricted to functional products. Criterion-based tools obey similar principles to CAT, where the creativity of a product is perceptible when appropriate independent observers agree it is creative (Amabile, 1982). However, reliable experts are expensive, and their availability is limited (Cropley et al., 2011). Also, further study of various aspects of functional products may lead to a higher customer value as well as an increase in profitability of the firms (Parida et al., 2013). From the creativity point of view, elements of *novelty* and *appropriateness* may significantly contribute. Consequently, the range of assessment in this research has been limited to functional products. This will generate more specific indicators, where product designers can apply at numerous design stages.

Figure 1 indicates the anticipated model representative of the criteria considered for the assessment of functional products. The new instrument is comprised of 9 criteria and 40 attributes of product creativity that are synthesised from literature. In order to be consistent with the definition of product creativity, all indicators were collected considering the main elements of *novelty* and *effectiveness*. Novelty is a leading concern and the common inflection point between all researchers (Cropley et al., 2011). However, consumer's precedence is that the solution must contain features such as cost-effectiveness, efficiency, and safety (i.e. appropriateness). Hence, the model presented in this paper consists of all facets from both elements.

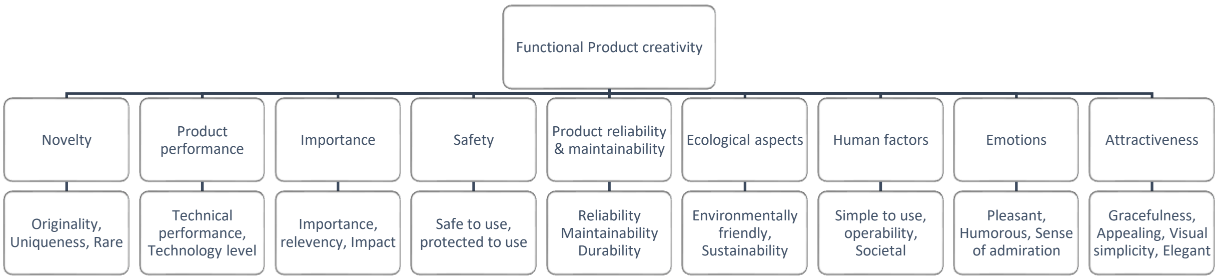

Figure 1. Anticipated model for measuring functional product creativity

In this instrument, the relationship between some of the factors and creativity has already been investigated. Besemer and O'Quin's (1986) Creative Product Semantic Scale has described creativity using terms such as novelty, resolution, elaboration and synthesis. This statement corresponds with their more recent findings (O'Quin and Besemer, 1999), where factor analysis confirmed the connection between creativity and novelty. In their study, *novelty* was further extended in other forms such as originality, uniqueness, unusualness. Despite the importance of *novelty*, the most challenging issue in the evaluation of product creativity is to understand the various characteristics of product *effectiveness*. Cropley et al. (2008) specified that functional creativity is dependent on the product's technical performance, safety, and sustainability. Therefore, fulfilling customer needs with optimal performance, while protecting the user against the potential hazards (i.e. safety) along with being compatible with the environment (i.e. ecological aspects), can effectively enhance the overall appropriateness levels.

Horn et al. (2006b) examined product creativity in accordance with customer perspective. They concluded that the product's attractiveness and emotional impact on the user could also contribute to the universal usefulness. Likewise, other researchers have labelled this as a critical stage for creativity evaluation (e.g. Christiaans et al., 2002). In the current study, emotional impact is measured taking advantage of the elements obtained from PrEmo instrument designed by Desmet (2005). PrEmo is a non-verbal self-report measurement tool that further defines emotion in other forms such as desire, pleasant, surprise, and inspiration. Nevertheless, the assessment of product impact on the consumer is not only restricted to the emotional characteristics but also needs the outcome to be sufficiently elegant. Several investigators (e.g. Cropley et al., 2011; O'Quin and Besemer, 1999; Besemer and O'Quin, 1986) have demonstrated the positive relationships between product attractiveness and gracefulness on overall creativity.

Gelernter (1998) characterised *elegance* as the confluence of aesthetics and usability. In other words, above and beyond the importance of product functionality, it is essential for the product to have a 'delicacy' in action. In this context, Feldman (2014) has further described and measured product elegance using terms such as gracefulness, or having a simple and smooth design. Despite the importance of *elegance*, many instruments (such as CPAM, CPSS) have argued other influential aspects of product creativity including product operability and simplicity. Moreover, another aspect of product creativity is the degree to which the function is relevant to the customer requirement. Often, researchers have described the product *relevancy* as a form of product *importance* (e.g. PCMI; Horn et al., 2006b).

Harold et al. (2009) reported that product maintainability and reliability are two essential elements affecting the product effectiveness. In a study by the American Society for Quality Control (Quality progress, 1986), the result of 1000 interviews revealed the similar outcomes. Their investigations placed product reliability and maintainability in the top five most important factors to customer. IEC 60050-191 (1990) has defined product reliability as a length of time set by the manufacturer in which product is functional under the ordinary condition. While, the ability of the product to be easily repaired within the stated lifetime is commonly known as the ratio of maintainability. Overall, taking into account the results of the literature review, the hypothesised model in this research is the fusion of optimised product creativity factors for functional products combined with new items capable of assessing the creativity in accordance with different product functionality.

3 METHODOLOGY

The new instrument is designed based on the theoretical framework of the criterion-based technique and comprised of indicators obtained from literature. Despite the existing experimental approaches, this study is also focused on the effects of the constituent elements of the experiment. Therefore, to clarify the reliability and validity of the proposed model, a novel empirical factor analysis experimentation is planned to extract the essential factors and confirm the final structure. Moreover, a pilot study has been conducted to investigate the fluency of the indicators in the surveys. Study I and II (that are currently in progress) are then proposed to inspect the effects of different types of product functionality on the underlying structure of the factor analysis.

3.1 Pilot study

To investigate the understandability of creativity indicators as well as the general instruction of the surveys, a pilot study was conducted. Initially, an email composed of a link to the web-based survey consisting of 40 creativity indicators, was sent to 22 college graduate students and 21 professional designers. This survey also comprised of a feedback section where judges can provide their individual opinions. Participants were 95% male ranging from 25 to 50 years old with a standard deviation of {SD}=10.2. Among the judges, 65.2% have at least an undergraduate degree and 26% have at least postgraduate degree. Out of the sample of 43, 23 responded to the survey in which they were instructed to observe a short video consisting of technical specification of a selected product (a DeWalt screwdriver). The results of this investigation is explored in the result and discussion section.

3.2 Panel of experts (Study I)

The Consensual Assessment Technique (CAT) is considered to measure the levels of product creativity using an appropriate panel of judges. Initially, nine products in three groups (i.e. A, B, C; see Figure 2) each with different types of functionality have been selected. Each group consisted a type of functionality that is prominent to at least to one or more criteria mentioned earlier in this research. These composed of (a) three drywall screwdrivers (b) three decorative wall clocks and (c) three fully electric-vehicles. The intended panel of experts is composed of 30 specialists divided into three groups (10 per group), while each assessing one type of functionality. Among the judges, 10 are professional constructors with a long experience in using tools; 10 expert designers who are involved in teaching for more than 15 years and have served various roles in industry; and the rest are either specialists in user experience design or technology.

A set of 3 surveys (one per functionality type) have been designed, and are currently in a sharing process with appropriate experts in each category. Judges will be independently asked to rank the creativity levels as well as the relevance between proposed criteria and the corresponding product functionality (see Figure 2). All assessments will be randomly performed using appropriate panel of judges and 5-point Likert type scaling system. Study 1, aims to recognise the most influential aspects of product creativity on various product functionality. Further, it can actualise the factor analysis examination (study II) by reducing the number of indicators and therefore the required sample size (see also participants). As a consequence, one product from each group that scored in between (i.e. neither creative nor uncreative) will be excluded from the second examination. Overall, comparing the outcomes of expert and novice measurement can provide extra validation to the proposed model.

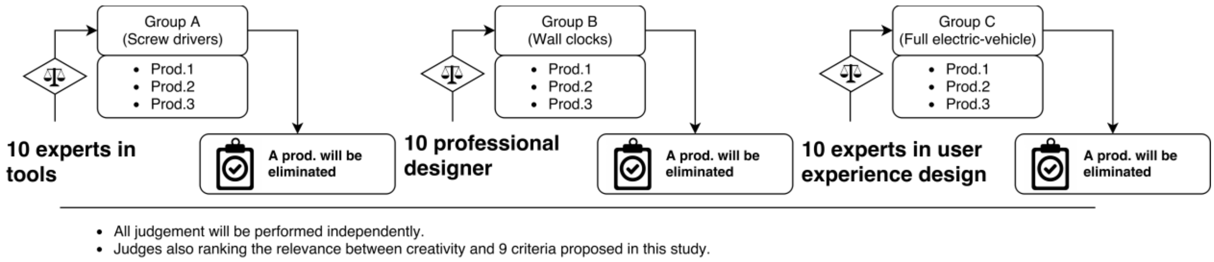

Figure 2. Schematic of CAT evaluation

3.3 Participants (Study II)

The CAT evaluation from study (I) can significantly reduce the number of participants from ~1000 to ~450 students. This is because the selection of indicators for each group includes those that are highly related to the corresponding product functionality and formally confirmed by experts in the domain. In this study, participants will be comprised of three groups of 120-150 volunteer undergraduate students (see Figure 3) from Imperial College London (ICL). According to the statistics released by ICL for 2015-16 (see https://www.imperial.ac.uk/), there are more than 9000 registered undergraduate students (aged from 18 to 30) out of which 61% are male students. Demographically, British students form 33% of the total community, Chinese with 18% and other major European countries with 16% are in the next positions. Although, the adequate sample size is attributed to several elements such as the number of indicators, missing data, and even communality ratios (MacCallum et al., 1999), an appropriate number of participants is usually identifiable after analysing the data. However, there are some advance rule-of-thumbs to which most of the SEM models (incl. this study) have established on their basis. These composed of a minimum sample size of 100 (Boomsma, 1982), or 5-10 observations per estimated parameter (Bentler et at., 1987).

3.4 Materials and task procedure (Study II)

To investigate the effects of different types of product on the underlying structure of the model, six products from the previous study will be used for the factor analysis test. Figure 3 indicates the experiment schematic where groups are categorised according to their functionality (i.e. constructive items, decorative items, and electric vehicles). Likewise, products of each group consist of creative and non-creative (or less creative) items that have been earlier judged by the panel of experts. This configuration will improve the testing quality and standardise the data, considering the fact that the existing relationship between creativity and indicators has already been investigated from further viewpoints using the CAT evaluation. An email containing a cover letter, QR code, and a link to the survey(s) will be sent to the participants in each group. Also, for reducing bias error from the experimentation, surveys will be randomly configured.

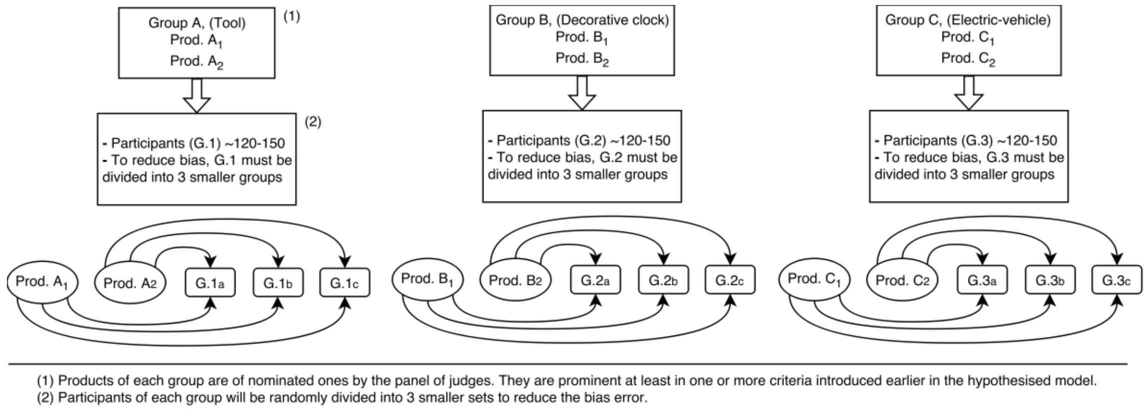

Figure 3. Experiment schematic for factor analysis

It is also worth mentioning that the creativity indicators for each group of surveys will be different depending on the corresponding product functionality. This arrangement will be in line with the findings of study (I), in which the panel of judges rank the most influential criteria of product creativity using the factors taken from the proposed model. Hence, on average 20 out of 40 creativity indicators will be utilised subjected to the corresponding product functionality. Afterwards, participants will be directed to an instruction page where they are guided through general information and given extra credit for their contribution. Then, product's technical specification, operability, and visual aspects will be demonstrated using a video (ca. 100 seconds). Later, participants will be asked to what extent they can recognise the creativity indicators using the 5-point Likert type scaling system (from 'not at all recognisable' to 'extremely recognisable'). Furthermore, the creativity levels of the products will be measured using self-awareness of the individuals belonging to each group (varying from 'not at all' through 'extremely').

3.5 Scale reliability (Cronbach's Alpha)

The coefficient alpha is employed to determine the ratio of internal consistency among the items at several stages of the current study. Many researchers have also used Cronbach's alpha as a standard measure for internal and inter-rater (replacing items as raters) consistency (e.g. Besember et al., 1998; Kaufman et al., 2007).

3.6 Factor Analysis (EFA & CFA)

Factor analysis is a statistical approach that requires a large sample size to reduce the number of factors and generate a structure for the observing variables. In creativity research, Exploratory Factor Analysis (EFA) and Confirmatory Factor Analysis (CFA) are widely employed to discover the influential criteria of product creativity (e.g. Besemer, 1998; Horn et al., 2009; see also Section 1). Fundamentally, EFA is applied in case no theoretical framework is existing to support the hypothesis required by CFA. In EFA, the primary task is to reduce the redundant items and deliver the underlying structure through taking advantage of an appropriate extraction (e.g. Principle Axis Factor) and rotation (e.g. Varimax or Promax) technique (Yong et al., 2013).

CFA is a measurement model that uses a multivariate regression model to describe the relationships between latent and observed variables that have been extracted from EFA test. However, to determine the residual matrix, CFA requires an estimation of the covariance matrix that is as close as possible to the sample data. This approximation can be done using an appropriate estimation method such as maximum likelihood technique. Then, applicable model fit indices such as chi-square, CFI, and RMSEA will be utilised to assess the goodness of fit of the new model. In this study, EFA will be employed due to the use of new creativity indicators as well as the lack of appropriate structure for the observing items, and to support the hypothesis required by CFA. Afterwards, CFA will be considered to measure the goodness of fit for each set of data (i.e. Group A, B, and C). However, before implementing the factor analysis, a few statistical assumptions must be primarily investigated. Kaiser-Meyer-Olkin measure of sampling adequacy, and Bartlett's test of sphericity will be used to indicate the extent to which the sample data is suitable for factor analysis. Fundamentally, both EFA and CFA require a large sample size (i.e. >100; see participants), where CFA assumes multivariate normality among the variables. To inspect the sample data for normality, Skewness and Kurtosis test of normality is considered where the acceptable range is ± 1.96 (Rose et al., 2015). EFA also needs the sample to be homogenous across the variances. In statistics, the Levene's test of homogeneity of variances is commonly carried out to determine whether each category of independent variables has appropriately perceived (Garson, 2012).

4 PILOT STUDY RESULTS AND DISCUSSION

The results of feedback section from the pilot study have been analysed to identify difficulties in operating the process as well as understanding the indicators. Items with complexity were rephrased or removed to control the smoothness of the questionnaire. Also, the data was inspected for missing values as well as normality using the Skewness and Kurtosis test. The Listwise technique was employed to exclude cases with missing data. This analysis led to 5 out of 23 completed surveys being removed from the examination. Further descriptive analysis of the data indicated that the data is normally distributed. Table 1 demonstrates the tilt ratio for several indicators of product creativity used in this experiment. For instance, the level of skewness for the item of 'safety' is obtained at 0.261 which shows an asymmetrical distribution but acceptable with a tail slightly extending to the right. Other variables also indicated the similar outcomes for Skewness and Kurtosis test of normality and calculated at the standard range of (-1.96, +1.96). Moreover, the results of the reliability test indicated an appropriate consistency among the items. The value of coefficient alpha (Cronbach's α) of the ratings performed by 23 judges who assessed 40 creativity indicators was calculated at an excellent ratio of .913.

Table 1. Skewness and Kurtosis test of normality (selected cases from pilot study)

Descriptive Statistics					
Statistic	N	Mean	{SD}	Skewness	Kurtosis
Unusualness	18	3.33	.970	-0.631	-1.215
Cutting edge Tech	18	3.17	1.339	-0.017	-1.057
Safety	18	3.17	.924	0.261	-.910
Reliability	18	3.33	.907	0.550	-.399
Operability	18	3.56	1.097	-0.296	-1.210
Satisfaction	18	3.06	1.211	-0.219	-.761
Appealing	18	2.83	1.043	0.036	.077

Overall, the results of the pilot study specified the applicability of the selected indicators on the questionnaire. Various statistical tests such as reliability (alpha) and normality (Skewness and Kurtosis) also revealed the adequacy of the instrument in collecting information. However, two studies (I&II) were designed to investigate the effects of different types of product functionality on the underlying factor structure. Study I use experts to examine the relationships between creativity and the proposed criteria for 9 products varying in the range of application. Consequently, in total 3 products that ranked as neither creative nor uncreative, will be eliminated from the rest of the investigation. Then, the nominated products will be evaluated for the extent to which three clusters of participant novices can recognise the selected indicators. It is worth mentioning that the indicators used in each survey are comprised of the criteria that previously categorised by the panel of judges.

It is believed that the results of this examination are of three dissimilar creativity assessment tools composed of either similar or in some part unique parameters. Further analysis of inter-item consistency is also required to illustrate the reliability of the outcomes. Likewise, the validity of the new instruments will be inspected through comparing the estimated factor loadings derived from CFA model with empirical data in study II. The maximum likelihood estimation method will be employed for this approximation. In addition, the results of creativity assessment using the panel of experts (CAT) will be further compared with the rankings extracted from EFA and CFA analysis. If similar results are obtained, it can be concluded that the proposed tools are capable of demonstrating the differences in product creativity. Overall, this research is exploring whether different categories of product functionality can affect the outcomes of the factor analysis test.

In other words, it is expected that the importance of specific creativity indicators might be diverging for different product functionalities. For instance, in decorative products, the indicators related to 'attractiveness' or 'emotions', should be able to explain higher percentages of the total variances comparing with others such as 'safety' or 'technical performance'. Also, this variation among the items is in agreement with the findings of Horn et al., (2006b) who used the exploratory and confirmatory factor analysis generating a creativity measurement model composed of six dimensions including resolution, emotion, centrality, importance, desire, and novelty. Whereas, later investigations of the same author with dissimilar types of product functionality resulted in a different model with three factors consisted of affect, importance, novelty (Horn et al., 2009).

5 CONCLUSION

In this study, the importance of product creativity evaluation has been investigated, resulting in a hypothesis that product functionality may alter the final outcomes of factor analysis. Thus, different creativity indicators might be required for the measurement of dissimilar functionalities. Two studies have been carefully designed to inspect the effects of different types of product functionality on the underlying structure when determining creativity indicators using factor analysis approaches. It is expected that the findings of the current study will result in assessment models capable of assessing various criteria of product creativity. Indeed, this research aims to indicate that the measurement of product creativity is diverging depending on various product functionality. Anticipated assessment models are expected to follow the criterion-based technique in which the evaluation process is effectively limited to functional products. Limiting the scope of measurement will result in more specific factors that can significantly save time and cost. Additionally, product designers can efficiently improve their innovation through taking advantage of the specific indicators of product creativity.

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