The Preliminary Validation of PCMI in the Context of Museum Creativity

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Abstract. This article aims to examine the findings from our previous research. Using the indicators from the PCMI model (Product Creativity Measurement Instrument) with the highest factor loading in each metric, six hypotheses have been proposed based on the previous conclusions, and an online survey was designed. One hundred seventy-four participants (43.10% males and 56.90% females, 51.15% consumers and 48.85% experts) across China were invited to assess the five Storm Bottles selected from the top museums worldwide. The result meets the criterion of reliability (Cronbach's α=0.95) and model fit. The result revealed that gender and expertise do not influence the perception of museum creativity. The data supported integrating Emotion, Attraction and Desire into the metric of Affect, and it is also proven that Affect rather than Novelty is the leading dimension impacting museum creativity. That Desire is a fast predictor for Creativity was supported by the result. Usefulness and Importance are found relevant, and positive relationships between Usefulness and Novelty, as well as Attraction, were witnessed.

1. Introduction

In the previous study, the authors of this paper found that the museum's creative industries are facing problems, and one of the dominant issues is the homogenization of the museum's creative products and the creativity deficiency in these kinds of products [1-9]. After reviewing the literature, we found no creativity measurement model designed for the museum's creativity. To fill the gap, we started the inquiry on the construction of a creativity measurement model for museum creativity. Before this paper, we conducted an online survey using five Storm Bottles from the top museums worldwide, and 224 participants were invited to rate the product samples independently (the overall Cronbach's α is 0.95) [10]. We analyzed the data in two steps and reported them in two papers. In the first paper of this serial, we analyzed the data by comparing the average scores of each dimension. We found: (1) Differences in gender and expertise may influence the measurement of creativity; (2) The products with high creativity share the same order of six metrics. Thus, there may be a "recipe" for improving product creativity; (3) Emotion is the leading dimension in high-creativity products. Therefore,

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this dimension may be dominant in creativity assessment; (4) Novelty is not predominant in the sample assessment, and this phenomenon may happen in other museum's cultural and creative products; (5) Usefulness is easily influenced by other factors, which may include the preferences and interests of customers; (6) Importance ranks the last in all dimensions among all products, and this may be caused by the fact that we used products with the same function [10]. In the second paper, we put all the data in a line chart and found metrics correlations in the PCMI model. The findings of this paper include: (1) Emotion, Attraction, and Desire have positive relevance, and they can be bundled as Affect; (2) Affect dimension other than Novelty is the factor that impacts creativity assessment of museums' creativity positively dominantly, and significantly; (3) Importance has little impact on Overall creativity score, and this dimension may be ignored; however, it needs further validation; (4) Resolution has significant negative relevance with Novelty, while it has positive relevance with Attraction; (5) Desire may be a fast predictor for Creativity, but it has not been validated .

This paper aims to prove the reliability and validity of previous studies' results, find evidence through statistical analysis to support the findings and amend the conclusion if needed. We will analyze the results by Stata, SPSSPRO and SmartPLS.

The main findings from the two previous studies are summarized as follows: (1) Gender and experience may influence the perception of museum creativity; (2) Affect rather than Novelty is the leading dimension that impacts museum creativity; (3) Emotion, Attraction and Desire can be bundled into the dimension of Affect; (4) Usefulness is quickly impacted by other dimensions such as Novelty and Attraction; (5) Importance is relevant to Usefulness. Based on this, we proposed hypotheses as follows (See Table 1).

Table 1. Hypotheses from the Previous Studies

Hypotheses	Statements
H1	Gender and experience influence the perception of museum creativity.
H2	Emotion, Attraction and Desire can be bundled into the dimension of Affect.
H3	Affect rather than Novelty is the leading dimension that impacts museum creativity.
H4	Desire is a fast predictor of Creativity.
H5	Usefulness is negatively impacted by Novelty and positively influenced by Attraction.
H6	Importance is relevant to Usefulness.

2. Method

Following the instruments used in previous studies [10], we used the PCMI model for this assessment. The metrics include Novelty, Usefulness, Emotion, Attraction, Importance and Desire [11]. In Horn's model validation stage, they identified 41 pairs of adjectives and then categorized them into 6 metrics, each with several pairs. Lu and Luh [12] felt that using the PCMI model is time-consuming. To save time, they introduced a strategy by which any indicators whose factor loadings are below the threshold (they set >0.8) will be discarded. Following such a strategy, we chose the metrics with the highest factor loading. We selected the positive polar from the list. The indicators are Rare, Functional, Appealed, Favorable, Important, and Desire. We adjusted them in the style of 5-point Likert Scales (1 represents the lowest score, and 5 means the highest score). Correspondingly, the museum creative products we use are still "Strom Bottles" [10, 13], namely, Gayer-Anderson Cat, Anubis, Rosetta Stone, Qianli Jiangshan, and William the Hippopotamus.

Our target participants are experts in the design domain and general consumers of museum creativity. We adopted the criterion of experts following the tradition of creativity research, where experts are defined as anyone with domain knowledge of more than 8 years [14-16]. One hundred seventy-four participants across China were invited to participate in our survey to improve the data's diversity. Regarding the gender of participants, 43.10% of them are males, and 56.90% are females. Regarding group division, 51.15% are general consumers, and 48.85% are experts. Our previous report includes detailed demographics and descriptive statistics [10].

3. Result

3.1 Reliability and Validity Test

The Cronbach's α is 0.925, indicating the data are of high reliability. The KMO and Bartlett's p-values are 0.86 and 0, respectively, supporting the factor analysis. The AVE values of the metrics generated in the process of confirmatory factor analysis are 0.495 (Rare), 0.466 (Functional), 0.663 (Appealed), 0.584 (Favorable), 0.53 (Important), and 0.543 (Desirable), indicating metrics except for Rare and Functional are well extracted. Table 2 shows that only the AVE square roots of Rare and Functional are more significant than other metrics' Pearson correlations, suggesting only these two metrics have excellent discriminant validity. The model is of good fit because GFI=1 (>0.9), RMR=0 (<0.05), CFI=0.993 (>0.9), NFI=1 (>0.9), and NNFI=1.018 (>0.9).

Table 2. Discriminant Validity: Pearson Correlations and AVE Square Root

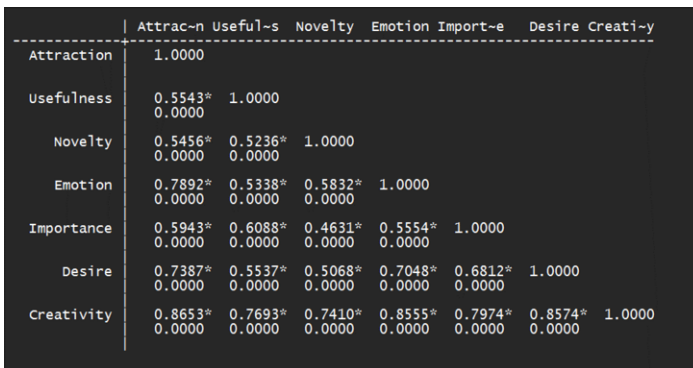|	Rare	Functional	Appealed	Favorable	Important	Desirable
Rare	0.704					
Functional	0.629	0.683				
Appealed	0.67	0.631	0.814			
Favorable	0.647	0.657	0.865	0.764		
Important	0.496	0.662	0.659	0.663	0.728	
Desirable	0.552	0.634	0.734	0.779	0.8	0.737

Figure 1. Pairwise Correlations Coefficients of the Metrics

We tested the correlations of each metric in Stata SE (V 17.0). In the process, we calculated the Correlation Matrix of the metrics, figured out the Pairwise Correlation Coefficients, and marked any value whose p-value is smaller than 0.001 with "*" (See Figure 1). As we can read from the report, the survey results are significant. The inner

correlations of the six metrics and their relationship with Creativity are all superficially positive. The results follow what we got from confirmatory factor analysis.

3.2 The Moderating Effects of Gender and Expertise

Through average score comparison, the previous study revealed that gender and expertise may influence the rating of museum creativity [10]. We tested the moderating effects of these two factors in SmartPLS. It was found that no such moderating effects on Creativity. Thus, we rejected H1 (Gender and expertise influence the perception of museum creativity).

3.3 The Metrics of Affect in Creativity Measurement

● The Correlation of Emotion, Desire, and Attraction

From Figure 1, we found that the correlation of the metrics is all positive. Moreover, the results are significant and of high reliability since the p-values are 0. In addition, we found the values of Attraction-Creativity, Emotion-Creativity and Desire-Creativity are over 0.8; therefore, we concluded they are highly relevant. We conducted further confirmation using SmartPLS with the PLS-SEM algorithm and Bootstrapping. Before data analysis, we followed the strategy of average score calculation, which is also used in the most predominant creativity assessment models, including the CAT and CPSS models [17]. We calculated the Affect Score for each sample by the formula (1), and the final data analysis report is shown in Figure 2.

$$\text{Pleasure Score} = \frac{\text{Emotion Score} + \text{Attraction Score} + \text{Desire Score}}{3} \quad (1)$$
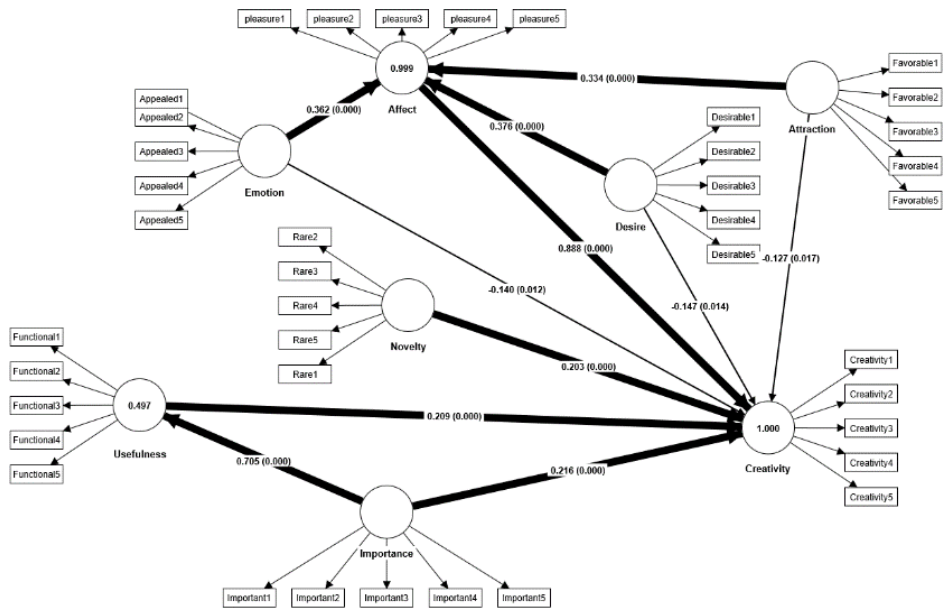

Figure 2. Path Coefficients and T values of the Metrics

In Figure 2, the values before the brackets along the path are Path Coefficients (β values), indicating the importance of the correlation between the Independent Variable

and Dependent Variable (e.g. Novelty is vital to Creativity). The report revealed that the three β values (Emotion-Creativity, Desire-Creativity, and Attraction-Creativity) are negative. In comparison, the four β values (Affect-Creativity, Desire-Affect, Attraction-Affect, and Emotion-Affect) are positive. The paths are considered valid since the positive β values fall in the range of [0,1]. The values in brackets are p values, suggesting the significance of Independent Variables on the Dependent Variable. Also, we found the p values and β values (Emotion-Affect, Desire-Affect, and Attraction-Affect) are relatively high compared with that of Emotion-Creativity, Desire-Creativity, and Attraction-Creativity which strengthens the possibility of regarding them as a bundle. Furthermore, the R2 is 0.999, indicating the model has an excellent explanation. Regarding the role of Affect in Creativity assessment, we found that the β value of Affect-Creativity is far more significant than that of Novelty-Creativity.
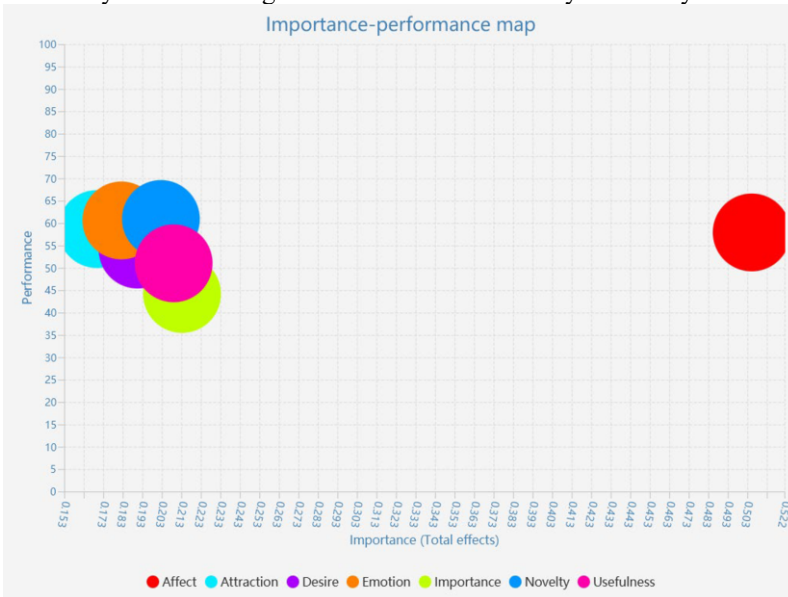

Figure 3. Results of Importance Performance Map Analysis

Figure 4. Pairwise Correlations Coefficients of the Metrics, Including the Affect Dimension

Following this analysis, we conducted Importance Performance Map Analysis (IPMA) in SmartPLS. It proved the role of the Affect in the creativity assessment for museum culture and creativity from another perspective. As we can see from the IPMA report (See Figure 3), the Affect has an extremely high value in the Importance Axis, suggesting the Affect rather than Novelty is the highest priority in creativity assessment.

Further, we validated the Affect dimension in Stata SE and discovered that the values of Affect-Creativity, Affect-Attraction, and Emotion-Affect are more significant than 0.9, and the value of Desire-Affect is near 0.9 (See Figure 4). These results indicate that the Affect dimension is highly relevant to Attraction, Emotion, and Desire. Moreover, the value of Affect-Creativity is more extensive than that of Novelty-Creativity, indicating Affect rather than Novelty is the leading dimension in museum creativity.

We noticed that the β values of Emotion-Creativity, Desire-Creativity, and Attraction-Creativity in Figure 2 are all negative. It may indicate that the Affect metric is a potential mediator. To confirm its role, we calculated the VAF value for each pair (Emotion-Affect-Creativity, Desire-Affect-Creativity, and Attraction-Affect-Creativity) by formula (1)-(3) and the corresponding VAF values are 176.9%, 179.6%, and 175.7%. Hair and Hult [15] pointed out that a VAF value greater than 80% can be considered "Full Mediation"; therefore, the Affect can be regarded as a mediator for Emotion, Attraction and Desire. Therefore, Emotion, Attraction and Desire can be bundled and even replaced by the Affect in creativity assessment for museum culture and creativity. Thus, we finally accepted hypotheses H2 (Emotion, Attraction and Desire can be bundled into the dimension of Affect) and H3 (Affect rather than Novelty is the leading dimension that impacts museum creativity).

● The Correlation of Desire and Creativity

Since the Desire and the Creativity Overall lines overlap, and the gaps are no more significant than 0.11 (See Table 3), we might use the score of the Desire aspect to fast predict the overall level of Creativity in museum culture and creativity.

Table 3. The Gaps between the Score of the Desire Dimension and the Overall Creativity

Product Sample	Desire	Creativity Overall Score	Absolute Gap Score
Gayer-Anderson Cat	3.33	3.32	0.01
Anubis	3.27	3.31	0.04
Rosetta Stone	3.24	3.24	0.00
Qianli Jiangshan	3.06	3.10	0.04
William the Hippopotamus	2.92	3.03	0.11

We analyzed the data with a t-test in Stata SE; the report is shown in Figure 5. From the result, we found the p values (0.1939, 0.3879, and 0.8061, respectively) are all larger than 0.05, supporting the hypothesis that Desire and Creativity are similar, and Desire can be used as a metric to fast predict the overall value of Creativity in museum cultural and creative products. Therefore, we accepted H4 (Desire is a fast predictor for Creativity).

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Two-sample t test with equal variances
-------------------------------------------------------------------------------
Variable |     Obs        Mean    Std. err.   Std. dev. [99.9% conf. interval]
---------+---------------------------------------------------------------------
  Desire | 1,110    3.157658    .0325646    1.084945    3.050216    3.265099
 Creati~y | 1,110    3.193844    .0263612    .8782669     3.10687    3.280818
---------+---------------------------------------------------------------------
Combined | 2,220    3.175751    .0209474    .9869739    3.106731    3.244771
---------+---------------------------------------------------------------------
    diff |         -.0361862    .0418971               -.1742338    .1018614
-------------------------------------------------------------------------------
    diff = mean(Desire) - mean(Creativity)                     t =    -0.8637
H0: diff = 0                                  Degrees of freedom =       2218

  Ha: diff < 0                    Ha: diff != 0                  Ha: diff > 0
 Pr(T < t) = 0.1939       Pr(|T| > |t|) = 0.3879        Pr(T > t) = 0.8061
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Figure 5. The t-test Result of Desire-Creativity

3.4 The Metrics of Usefulness and Importance in Creativity Measurement

As per Maslow's human need model, museum cultural and creative product does not belong to the category of daily necessity; thus, the importance of this category is low. Complaints about the Usefulness and function of the products are often witnessed in reports and surveys [18]. Based on this fact, we decided to examine the Usefulness metric closely.

● *The Correlation of Usefulness and Novelty*

Our previous study pointed out that the possible reason to explain this phenomenon is that Novelty and Attraction, besides Importance, impact Usefulness. We visually discovered that Novelty is a factor that may influence Usefulness negatively. However, the Pairwise Correlations Coefficient offered by Stata SE (value=0.5236, see Figure 1) in our research has not proven it. Moreover, the Linear Trend Test report (See Figure 6, Prob > F = 0.0000) confirms the positive correlation between Usefulness and Novelty.
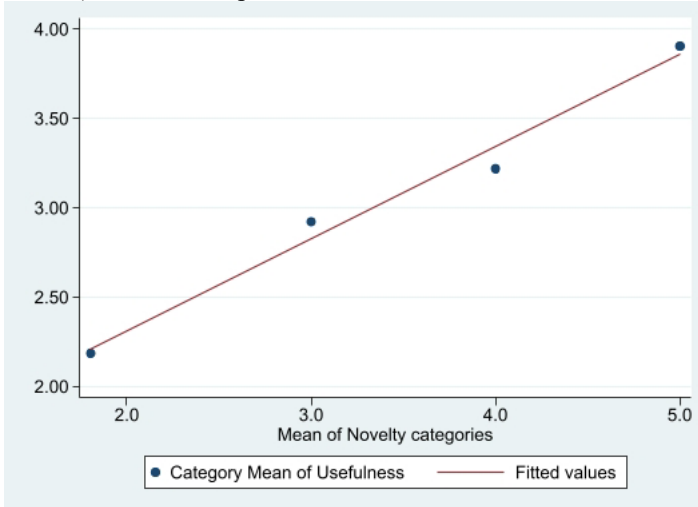

Figure 6. The Linear Trend Test Report for Usefulness and Novelty

● *The Correlation between Usefulness and Attraction*

As stated in our previous studies, apart from the impact of Novelty, Attraction may be another factor that positively impacts Usefulness. As the Pairwise Correlations Coefficient by Stata SE (value=0.5543, see Figure 1) and the Linear Trend Test report (See Figure 7, Prob > F = 0.0000) indicate, the correlation is confirmed as positive too.
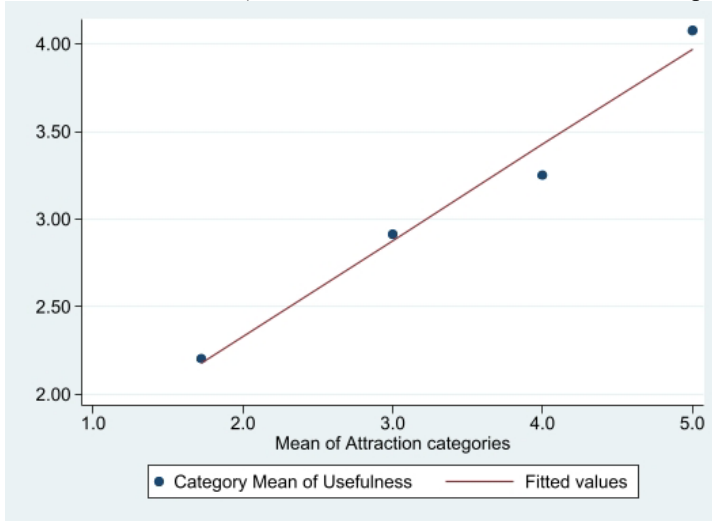

Figure 7. The Linear Trend Test Report for Usefulness and Attraction

● *The Correlation between Usefulness and Importance*

We found the line of Importance lies at the bottom of the chart and discovered the two Creativity Overall (one excludes Importance, and another includes) lines parallel on most occasions except causing a slight drop in the Overall score of Anubis. It seems that Importance has little influence on the Creativity Overall score except by pulling down the numeric value. However, it needs further confirmation. To confirm the role of Importance, we calculated the VAF value (Variance Accounted For) for Usefulness-Importance-Creativity. The VAF values of Usefulness and Importance are 40.5% and 42.1%, respectively, falling from 20% to 80%. Hair, Hult, Ringle, and Sarstedt (2014) pointed out that the VAF value between 20% and 80% can be considered "Partial Mediation", meaning Importance is a partial mediator in the correlation of Usefulness-Creativity.

In sum, H5 (Usefulness is negatively impacted by Novelty and positively influenced by Attraction) is only partially supported by the result because the impacts of Novelty and Attraction on Usefulness are proven all positive. Moreover, H6 (Importance is relevant to Usefulness) is accepted since we have found a mediating effect between Importance and Usefulness.

In sum, we obtained the decisions for the proposed hypotheses (See Table 4).

Table 4. Decisions of the Hypotheses

Hypotheses	Statements	Decisions
H1	Gender and experience influence the perception of museum creativity.	Rejected
H2	Emotion, Attraction and Desire can be bundled into the dimension of Affect.	Accepted

Hypotheses	Statements	Decisions
H3	Affect rather than Novelty is the leading dimension that impacts museum creativity.	Accepted
H4	Desire is a fast predictor of Creativity.	Accepted
H5	Usefulness is negatively impacted by Novelty and positively influenced by Attraction.	Partially Accepted
H6	Importance is relevant to Usefulness.	Accepted

4. Discussion

Theoretically, gender is the influencing factor because most museum creativity consumers are females, confirmed by the big data from the Taobao market [19]. The appearance of the creative products easily attracts females; thus, they may be more sensitive to the perception of museum creativity. Intuitively, design experts have seen more creative products in their surroundings. Thus, they may be more critical to museum creativity. In other words, they tend to rate the creativity score lower than the consumers. However, these preconceived notions are not supported by this research. Instead, we found that gender and expertise do not affect the perception of museum creativity.

The finding that Emotion, Attraction and Desire can be bundled into the dimension of Affect is per the discovery of Horn and Salvendy [20]. In this research, we have used multiple means, such as PLS-SEM and IPMA, to prove that this integration is reliable in museum creativity. We also detected that Affect mediates Emotion, Attraction and Desire in Creativity. This finding also supports our previous conference papers [10, 13]. We also found that Affect is the leading metric that significantly impacts the perception of Creativity, which corresponds with our previous in-depth investigation [13]. However, we are uncertain about the working mechanism of the Affect dimension on overall Creativity. Because Affect is usually evoked by other visual and olfactory factors of a product, including the shape, the texture, the color, or even the odor, these attributes can be labelled as Aesthetics and the Affect triggered is called Aesthetic Pleasure.

Our research supported the notion that Desire is a fast predictor of museum creativity. Horn and Salvendy [11] defined Desire as the product's desirability to a consumer. As we all know, product purchase balances the product's attributes, including appearance, function, uniqueness, and price. If the consumer desires to own the product eagerly, it may suggest it is satisfactory in almost all aspects. Otherwise, the consumer will not have any desire to purchase it. However, since few pieces of the literature revealed that Desire can fast predict Creativity, we decided to test this hypothesis further.

We discovered that Novelty and Attraction positively influence the perception of a product's functionality. Since we also proved that Importance is relevant to Usefulness, we may infer that Novelty and Attraction impact Usefulness and Importance. The reason for the influencing mechanism is that when consumers or their attentions perceive the uniqueness of a product, they may exaggerate the perception of the product's Importance and add extra values beyond the functionality.

We witnessed an imperfection in the process of confirmatory factor analysis where some indicators failed to meet the threshold of the statistical criteria. Since we reserve only one indicator with the highest factor loading for each metric, it is impossible to delete the unsatisfactory ones. Although the strategy introduced by Lu and Luh [12] did have at least more than two indicators for each metric, it is less rigorous to delete the indicators based on the factor loadings of the model inventors because the factor loadings are context-specific. In other words, the original PCMI model is tested in generic products, which is not the same context as museum creativity. Thus, transplanting the

factor loadings of metrics into museum creativity faced unexpected challenges in the validity test.

5. Conclusion

This paper tested the findings concluded in our two previous conference papers. This research found that gender and expertise do not influence the perception of museum creativity. The data supported integrating Emotion, Attraction and Desire into the metric of Affect, and it is also proven that Affect rather than Novelty is the leading dimension impacting museum creativity. We also discovered that Desire is a fast predictor of Creativity. Although we can find the explanation in the product purchase process, we must further validate the hypothesis. Usefulness and Importance are found relevant, and positive relationships between Usefulness and Novelty, as well as Attraction, were witnessed. This research's main drawback is the indicators we used in the survey. Although the strategy of reducing indicators is from the literature, we faced unexpected indicators' validity issues in the validity test stage. The suggestion for validating the PCMI model in a new realm is to use the whole set of indicators rather than adopting some strategies to reduce the number of indicators.

Acknowledgments

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