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Thermoplastic Polyurethane Based on the 3d Printing Fashion Clothing- Conceptual Model of The Fashion Industry

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Abstract
The application of 3D printing technology has been relatively slow in the fashion industry. Both in the fashion industry and in 3D printing, the material used plays a very important role. In this direction, thermoplastic polyurethane (TPU) is one material that has started to grab the attention of researchers, producers, and customers. While many have studied 3D printing technology using thermoplastic polyurethane material in the fashion industry from different perspectives, fewer researchers have addressed the actual adoption of thermoplastic polyurethane based 3D printing in the fashion industry. Thus, the present research has been focused to propose an adoption model for thermoplastic polyurethane based 3D-printed fashion clothes. Factor analysis was conducted to find and analyse the most relevant factors. Further exploratory factor analysis was conducted to test the proposed model. The study proposed a model for adoption based on four factors: motivation to buy, customer attitude, and the challenges and benefits associated with the adoption of thermoplastic polyurethane based 3-D printed fashion clothes.

Keywords
TPU, 3D printing, fashion industry, customer adoption, Kaiser-Meyer-Olkin test, Bartlett's test, conceptual model.

1. Introduction

3D printing is one of the most speedily growing technologies in different sectors including the fashion industry. Though it is being implemented in the fashion industry, the application of 3D printing technology has been relatively slow in this sector owing to aspects like limitations related to materials, problems in the procurement of the technology, and concerns about whether the product should be worn on the human body [1].

1.1. Thermoplastic Polyurethane Based Material 3D Printing and the Fashion Industry

Many researchers in the past have conducted studies on the use of 3D printing in the fashion industry. Vanderploeg et al., (2017) [2] conducted research on different applications of 3D printing in the fashion industry, Sun & Zhao, (2017) [3] presented a model on the impact and challenges of the use of 3D printing in the fashion industry, Chun, (2017) [4] studied the use of 3D printing technology to cultivate new designs, D. Sun & Valtasa, (2019) [5] conducted research on the integration of 3D printing technology into fashion clothing production processes, McCormick et al., (2020) [6] studied the Chinese fashion market for use of 3D printing, Spahiu et al., (2020) [7] researched 3D printing techniques.

Both in the fashion industry and in 3D printing, the material used plays a very important role. In this direction, one material that has started to grab the attention of the researchers, producers, and customers is thermoplastic polyurethane (TPU). It is known for its outstanding material properties like tear resistance, resistance to chemicals, abrasion resistance, skin compatibility, large elongation break, resistance to ozone, low-temperature resistance, resistance to oxygen, low long-term deformation rate, resistance to oil and fuels, antimicrobial properties, resistant to fungus, soft elasticity, and excellent bending and tension strength [9,10]

TPU can be coated onto a piece of fabric to deliver protection, comfort, and aesthetic values to the fabric. Owing to these properties and properties enlisted in Figure 1, TPU is considered to be a good choice for making garments and textiles. Owing to these aspects, many researchers have studied the use of TPU material for 3D printing fashion products. Kim et al., (2019) [1] and Han & Kim, (2018) [11] studied the use of TPU-based material for 3D printing fashion products, Jin & Li, (2020) [12] researched the development of 3D printing clothing using TPU material, Jeong et al., (2021) [13] used TPU material in 3D printing for developing parametric design in fashion products. Although TPU has certain limitations such as its rough feel and limitations in creating diverse designs such as those with severe curves, its biggest advantage is that it is sustainable, which makes it worth adopting.

While many have studied 3D printing technology using TPU material in the fashion industry from different perspectives, fewer researchers have addressed the actual adoption of TPU-based 3D printing in the fashion industry. Thus, the present research has been focused to propose an adoption model for TPU-based 3D-printed fashion clothes.

1.2. China and the Fashion Industry

The Chinese fashion industry is growing rapidly. This can be attributed to the fact that the purchasing power of the Chinese population is at its peak. Now, fashion has become an important for the Chinese population, and clothing is no longer a mere necessity. Moreover, fashion is now one of China's most lucrative industries. Not only local, but also foreign companies are looking for ways to get a strong foothold in the fashion market of the world's most populous country. Today, the Chinese fashion market is the second-largest apparel market in the world with an estimated value of USD 2 billion [14]. This scenario of the Chinese fashion industry makes it vital to study TPU-based 3D printed fashion clothes because TPU has the potential to be the future of fashion and the Chinese fashion market, which holds the maximum potential in the world as it has the biggest consumer market).

2. Research aims

TPU is a comparatively new topic in the fashion world, which is why only a moderate amount of research has been conducted on it. It holds a bright future as the world is moving towards sustainability. The research that has been conducted so far on TPU usually discusses the challenges and/or opportunities of adopting TPU. But no research till now has focused on how to adopt it even though the material holds such huge potential. Thus, it is imperative to provide a framework for the adoption of TPU in the fashion industry so that the industry is able to completely utilize its excellent mechanical properties, and thereby make it more suitable and sustainable while dealing with as few hindrances as possible. Thus, the present research has focused on providing a conceptual framework for the adoption of TTPU-based 3D printed material.

3. Theoretical Framework

The present research is based on providing a conceptual framework for the adoption of TPU-based 3D printed material. Adoption is done on two fronts – namely, the customer front the and producer front. On the side of the customer, adoption depends on consumer behaviour. Consumer behaviour is dependent on motivation to buy and customer attitude [15–19]. In the same direction, Duggal, (2018) [20] found that understanding consumer motivation has become very important as it facilitates the producer in understanding the focus of the customer. Furthermore, the researcher stated that customer attitude facilities understanding the reason behind customer behaviour. This means the motivation to buy and customer attitude are significant factors to assess when discussing adoption. Also, when it comes to producers, the challenges and benefits associated with adoption impact adoption the most [3, 21, 22]. In this direction, Berger et al., (2020) [23] stated that for the successful adoption of any product, it is important to assess the perceived challenges and benefits on the customer side. This means it is imperative to assess the challenges and benefits of adoption. Thus, the present research has focused on these four factors namely motivation to buy and customer attitude, and the challenges and benefits associated with the adoption of TPU-based 3-D printed fashion clothes.

4. Material and Methods

In the present research, the deductive approach has been used. The study was conducted in China. Two populations of respondents have been used. The first is named "Producers". The producer population includes the managerial level employees of different textile companies associated with 3D printing on TPU material in China, working in departments – namely, Fabric Testing Lab, Production Planning and Control, Quality Control department and Printing departments. The second population is "Customers". The Customer population includes present and potential buyers who approach different fashion houses in China to enquire about and buy 3D printing fashion clothes made of TPU material.

For the administration of questionnaires for producers, they were e-mailed to the managerial employees in form of Google forms. The e-mail ids of the respondents were collected from the HR department of their associated companies. A total of 100 questionnaires were e-mailed out, of which 87 filled questionnaires were received. Furthermore, for the administration of questionnaires for customers, the fashion houses dealing with 3D-printed TPU-based clothes were approached and asked their customers to fill them in. The items used for the study are presented in Table 1 below-

Analysis of the collected data has been done through quantitative analysis software SPSS 23.0 and AMOS 26.0. Firstly, factor analysis was conducted to find the most relevant factors. Further Exploratory factor analysis was conducted to test the proposed model.

5. Results

5.1. Factor Analysis for Benefits of TPU-Based 3D Printed Fashion Clothes for Producers

The items considered under Benefits of TPU-Based 3D printed fashion clothes have been enlisted in Table 1.

Table 2 presents KMO- Bartlett test. A high value of KMO (0.925) indicates that the factor analysis may be useful with the data collected for the Benefits of TPU Based 3D Printed Fashion Clothes. Since Bartlett's Test reported a statistically significant value of 0.000 (<0.05) further stating factor analysis may be useful with the data collected for benefits of TPU-Based 3D printed fashion clothes

Since the study reported appropriate values for KMO-Bartlett test, the researchers moved ahead with Factor Analysis as follows.

Here, high extraction values (>0.5) were obtained which indicate that the factors thus received are good as the proportion of each variable's variance that can be explained by the retained factors are high.

The total number of factors retained in the total variance explained test is two.

Short-form	Original Factor
	Items under Benefits of TPU Based 3D Printed Fashion Clothes
B1	3D-printed parts with TPU are durable
B2	Such material can withstand ambient temperatures of up to 80 degrees Celsius
B3	Available in a range of colours
B4	Good vibration damping and shock absorption
B5	Chemical-resistant
B6	Low warpage and shrinkage
B7	Can be very stretchy depending on the elongation at the break
B8	Elastic and soft material
B9	Simulates rubber-like characteristics
B10	Good chemical and thermal stability
B11	Excellent printability
B12	Semi-transparent
B13	Better chemical resistance to oils and greases
B14	Hard flex filament facilitating 3D printing
B15	Scratch-resistant
	Items under Challenges of TPU Based 3D Printed Fashion Clothes
C1	While it is possible to print TPU using a desktop printer, the flexible filament is difficult to work with as it can easily disrupt layer thickness and jam or clog the printhead.
C2	TPU 3D printed parts also take much longer than traditional non-flexible materials because the print speed must be reduced.
C3	Depending on the make and model of the extrusion printer, the shore hardness of the TPU filament can be limited.
C4	If the temperature is too high, stringing can occur
C5	If the temperature is too low, layer adhesion will be poor
C6	Resistance to UV light is poor
C7	Needs to be printed at low temperatures
C8	Difficult to post-process
C9	Degrade in wet conditions
	Items under Motivation to adopt TPU Based 3D Printed Fashion Clothes for Customer
M1	High Quality
M2	Design and Aesthetics
M3	Feel and fit of the material
M4	To fit in with friends
M5	Esteem of Brand
M6	Follow the trend
M7	Value of Money
M8	Brand Name
M9	Show off
M10	To differentiate myself from others
M11	To protect environment
M12	I like to try new and innovative products
M13	TPU material based 3D printing fashion clothes are the future of the fashion industry
M14	The media significantly influenced me to make the purchase
M15	Representation of celebrities Associates with TPU material based 3D printing fashion clothes influence me into purchasing them

Table 1. Items Used in the Research for Creating Model of TPU-Based 3D Printed Fashion Clothes

Short-form	Original Factor
Items under Attitude towards adoption TPU Based 3D Printed Fashion Clothes for Customer	
Consumer knowledge	
CK1	My knowledge about TPU material based 3D printing fashion clothes is sufficient.
CK2	My knowledge about TPU material-based 3D printing fashion clothes is based on previous experience such as purchasing/consuming/hearing from others/reading about it.
CK3	I have a positive experience/impression about TPU material-based 3D printing fashion clothes .
Environmental concern	
EC1	I pay a lot of attention to the environment
EC2	The environmental aspect is very important in my purchase intention.
EC3	I believe that TPU material-based 3D printing fashion clothes is more environmentally friendly than conventional clothes.
Personal norm	
PN1	I feel I should choose TPU material-based 3D printing fashion clothes instead of conventional fashion clothes.
PN2	I get a good conscience about myself if I choose TPU material-based 3D printing fashion clothes.
PN3	I believe that choosing TPU material based 3D printing fashion clothes is a right decision
Subjective norm	
SN1	When it comes to choosing TPU material based 3D printing fashion clothes, I behave as others do.
SN2	Due to the impact of social pressure (society, environment, social network, etc), I choose TPU material-based 3D printing fashion clothes .
SN3	Most people who are important to me would like me to choose TPU material-based 3D printing fashion clothes.
Purchase intention	
PI1	I would often like to purchase TPU material based 3D printing fashion clothes
PI2	I am more likely to purchase TPU material based 3D printing fashion clothes next time going shopping.
PI3	I am willing to pay extra for TPU material based 3D printing fashion clothes.

Continued Table 1. Items Used in the Research for Creating Model of TPU-Based 3D Printed Fashion Clothes

KMO and Bartlett's Test		
Kaiser-Meyer-Olkin Measure of Sampling Adequacy.		0.925
Bartlett's Test of Sphericity	Approx. Chi-Square	1660.795
	Df	105
	Sig.	0.000

Table 2. KMO- Bartlett Test for Benefits of TPU-Based 3D Printed Fashion Clothes

Furthermore, these two factors account for 77.85% of the variance, which is a respectable number pointing towards the credibility of the retained factors. The number of factors retained can further be observed in the Scree Plot presented in Figure 1(a). It can be observed in Figure 1(a) that factor 1 and factor 2 possess the highest Eigenvalues, thereby contributing to the highest variance. Post the second factor, the line is almost flat, meaning each successive factor is accounting for smaller and smaller amounts of the variance.

Table 3 presents the items segregated under two factors. It can be seen B2 and B4 lie under factor 2 while all other items lie in factor 1.

On analyzing the items under factor 1 and factor 2 (Table 1), it was found that the items under factor 1 were Customer Related Benefits, while those under factor 2 were strength related. Thus, factor 1 was named Customer-Related Benefits, while factor was called Strength-Related Benefits

5.2. Factor Analysis for Challenges of TPU-Based 3D Printed Fashion Clothes for Producers

Items considered under Challenges of TPU-Based 3D Printed Fashion Clothes have been enlisted in Table 1.

Table 4 presents KMO-Bartlett Test. A high value of KMO (0.899) indicates that the factor analysis may be useful with the data collected for challenges of TPU based 3D printed fashion clothes. Since Bartlett's Test reported a statistically

Rotated Component Matrix[a]		
	Component	
	1	2
B1	0.958	
B2		0.761
B3	0.874	
B4		0.887
B5	0.941	
B6	0.815	
B7	0.905	
B8	0.677	
B9	0.858	
B10	0.865	
B11	0.864	
B12	0.892	
B13	0.913	
B14	0.860	
B15	0.889	
Extraction Method: Principal Component Analysis. Rotation Method: Varimax with Kaiser Normalization. [a]Rotation converged in 3 iterations		

Table 3. Rotated Component Matrix

KMO and Bartlett's Test		
Kaiser-Meyer-Olkin Measure of Sampling Adequacy.		0.899
Bartlett's Test of Sphericity	Approx. Chi-Square	703.069
	Df	36
	Sig.	0.000

Table 4. KMO- Bartlett Test for Challenges of TPU Based 3D Printed Fashion Clothes

Rotated Component Matrix[a]		
	Component	
	1	2
C1	0.879	
C2	0.887	
C3		0.898
C4	0.978	
C5	0.873	
C6	0.825	
C7	0.894	
C8		
C9	0.902	
Extraction Method: Principal Component Analysis. Rotation Method: Varimax with Kaiser Normalization.		
[a] Rotation converged in 3 iterations.		

Table 5. Rotated Component Matrix for Challenges of TPU-Based 3D Printed Fashion Clothes

significant value of 0.000 (<0.05) further stating factor analysis may be useful with the data collected for challenges of TPU based 3D printed fashion clothes

Since the study reported appropriate values for KMO-Bartlett Test, the researchers moved ahead with Factor Analysis as follows

Here, high extraction values (>0.5) were obtained, which indicates that the factors thus received are good as the proportion of each variable's variance, which can be explained by the retained factors being high except for item C8 (0.202).

The total number of factors retained in the total variance explained test is two. Also, these two factors account for 74.121% of the variance, which is a respectable number pointing towards the credibility of the retained factors. The number of factors retained can further be observed in the Scree Plot (Figure 1 b). It can be observed in Figure 1 (b) that factor 1 and factor 2 possess the highest Eigenvalues, thereby contributing to the highest variance. Post the second factor, the line is almost flat, meaning each successive factor is accounting for smaller and smaller amounts of the variance.

Table 5 presents the items segregated under two factors. It can be seen C3 lies under factor 2 while all other items lie in factor 1. Further, the correlation value of C8 was extremely small, which is less than 0.5 owing to which it has not been categorized under any factor.

Re-running the test after the removal of item C8. Post removal of C8, the value of KMO increased from 0.889 to 0.904.

Here, high extraction values (>0.5) were obtained which indicate that the factors thus received are good as the proportion of each variable's variance that can be explained by the retained factors are high.

Post-removal of item C8, the total number of factors retained is still two. Further, the variance accounted for by these two factors post-removal of C8 increased from 74.121% of variance to 82.925% thereby enhancing the credibility of the retained

KMO and Bartlett's Test		
Kaiser-Meyer-Olkin Measure of Sampling Adequacy.		0.904
Bartlett's Test of Sphericity	Approx. Chi-Square	697.302
	Df	28
	Sig.	0.000

Table 6. KMO- Bartlett Test for Challenges of TPU-Based 3D Printed Fashion Clothes Post Removal of Item C8

Rotated Component Matrix[a]		
	Component	
	1	2
C1	0.881	
C2	0.902	
C3		0.996
C4	0.975	
C5	0.871	
C6	0.837	
C7	0.897	
C9	0.893	
Extraction Method: Principal Component Analysis. Rotation Method: Varimax with Kaiser Normalization.		
[a] Rotation converged in 3 iterations.		

Table 7. Rotated Component Matrix for Challenges of TPU Based 3D Printed Fashion Clothes Post Removal of Item C8

KMO and Bartlett's Test		
Kaiser-Meyer-Olkin Measure of Sampling Adequacy.		0.897
Bartlett's Test of Sphericity	Approx. Chi-Square	9176.643
	Df	105
	Sig.	0.000

Table 8. KMO-Bartlett Test for Motivation to adopt TPU-Based 3D Printed Fashion Clothes for Customers

factors. This depicts an improvement in the quality of the retained factors.

It can be observed in Figure 1(c) that factor 1 and factor 2 possess the highest Eigenvalues, thereby contributing to the highest variance. Thus, not much difference was observed from the Scree plot with C8 (Figure 1c).

Table 7 presents the items segregated under two factors. It can be seen C3 lies under factor 2 while all other items lie in factor 1 which is the same as was the case with a rotated component matrix with item C8 (Table 10). Further, the correlation value of C3 can be observed to be increased from 0.898 to 0.996 post-removal of C8.

On analysing the items under factor 1 and factor 2 (Table 1), it was found that the items under factor 1 were TPU material related challenges while those under factor 2 were printer related. Thus, factor 1 was named TPU Material Related Challenges while factor was called Printer Related Challenge.

5.3. Factor Analysis for Motivation to adopt TPU-Based 3D Printed Fashion Clothes for Customers

The items considered under Motivation to adopt TPU-Based 3D Printed Fashion Clothes for Customers have been enlisted in Table 1.

Table 8 presents KMO-Bartlett Test. A high value of KMO (0.897) indicates that the factor analysis may be useful with the data collected for Motivation to adopt TPU-based 3D printed fashion clothes for customers. Since Bartlett's Test reported a statistically significant value of 0.000 (<0.05) further stating that factor analysis may be useful with the data collected.

Since the study reported appropriate values for KMO- Bartlett Test, the researcher moved ahead with Factor Analysis as follows. Here, high extraction values (>0.5) were obtained, which indicate that the factors thus received are good as the proportion of each variable's variance that can be explained by the retained factors are high.

The total number of factors retained in the total variance explained test is two. Furthermore, these two factors account for 98.985% of the variance, which is a respectable number pointing towards the credibility of the retained factors.

The number of factors retained can further be observed in the Scree Plot (Figure 1(d))

It can be observed in Figure 1(d) that factor 1 and factor 2 possess the highest Eigenvalues, thereby contributing to the highest variance. Post the second factor, the line is almost flat, meaning each successive factor is accounting for smaller and smaller amounts of the variance.

Table 9 presents the items segregated under two factors. Some cross-loadings can be observed. Thus, the factor with a higher correlation was selected to keep the item. Herein M1 to M6 has been allotted to Factor 2 while M7 to M15 are under factor 1.

On analyzing the items under factor 1 and factor 2 (Table 1), it was found that the items under factor 1 revolved around customers, while those under factor 2 were focused on brands. Thus, factor 1 was named Brand Specific Motivation,

Rotated Component Matrix[a]		
	Component	
	1	2
M1		0.769
M2	0.502	0.812
M3	0.521	0.792
M4		0.906
M5		0.882
M6		0.906
M7	0.753	0.533
M8	0.736	0.541
M9	0.811	
M10	0.908	
M11	0.904	
M12	0.912	
M13	0.867	
M14	0.869	
M15	0.798	0.543
Extraction Method: Principal Component Analysis. Rotation Method: Varimax with Kaiser Normalization.		
[a] Rotation converged in 3 iterations.		

Table 9. Rotated Component Matrix for Challenges of TPU-Based 3D Printed Fashion Clothes

KMO and Bartlett's Test		
Kaiser-Meyer-Olkin Measure of Sampling Adequacy.		0.795
Bartlett's Test of Sphericity	Approx. Chi-Square	2433.364
	Df	105
	Sig.	0.000

Table 10. KMO-Bartlett Test for Attitude towards adoption TPU-Based 3D Printed Fashion Clothes for Customers

Rotated Component Matrix[a]				
	Component			
	1	2	3	4
CK1	0.592	0.518		
CK2	0.546			
CK3	0.561	0.525		
EC1				0.838
EC2				0.788
EC3				0.843
PN1			0.936	
PN2			0.877	
PN3			0.899	
SN1		0.747		
SN2		0.919		
SN3		0.882		
PI1	0.923			
PI2	0.865			
PI3	0.851			
Extraction Method: Principal Component Analysis. Rotation Method: Varimax with Kaiser Normalization.				
[a] Rotation converged in 6 iterations.				

Table 11. Rotated Component Matrix for Attitude towards adoption of TPU- Based 3D Printed Fashion Clothes

while factor 2 was called Customer-Centric Motivation.

5.4. Factor Analysis for Attitude on adopting TPU-Based 3D Printed Fashion Clothes by Consumers

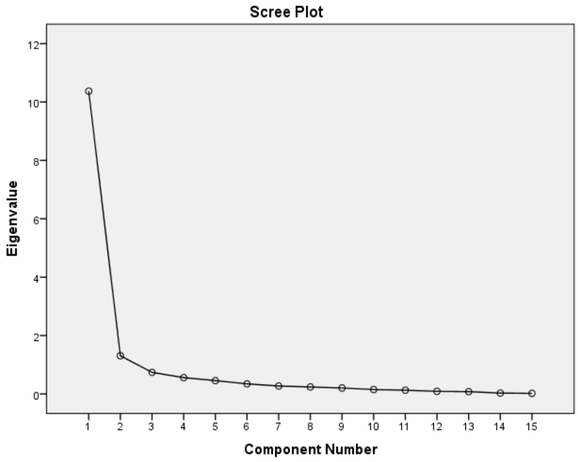
Table 10 presents KMO Bartlett Test. A high value of KMO (0.795) indicates that the factor analysis may be useful with the data collected for Attitude towards the adoption of TPU-Based 3D Printed Fashion Clothes for Customers. Since Bartlett's Test reported a statistically significant value of 0.000 (<0.05) further stating factor analysis may be useful with the data collected.

Since the study reported appropriate values for KMO-Bartlett Test, the researcher moved ahead with Factor Analysis as follows. Here, high extraction values (>0.5) were obtained which indicate that the factors thus received are good as the proportion of each variable's variance that can be explained by the retained factors are high except.

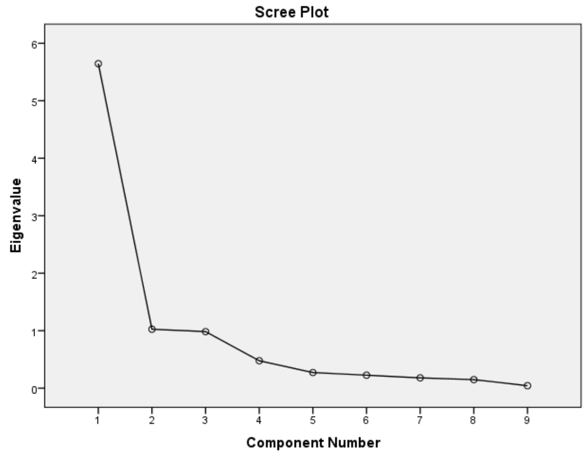
The total number of factors retained is four. Furthermore, these four factors account for 78.828% of the variance, which is a respectable number pointing towards the credibility of the retained factors. The number of factors retained can further be observed in the Scree Plot (Figure 1(e).

It can be observed in Figure 1 (e) that factors 1, 2, 3, and 4 possess the highest Eigenvalues thereby contributing to the highest variance. Post the fourth factor, the line is almost flat, meaning each successive factor is accounting for smaller and smaller amounts of the variance.

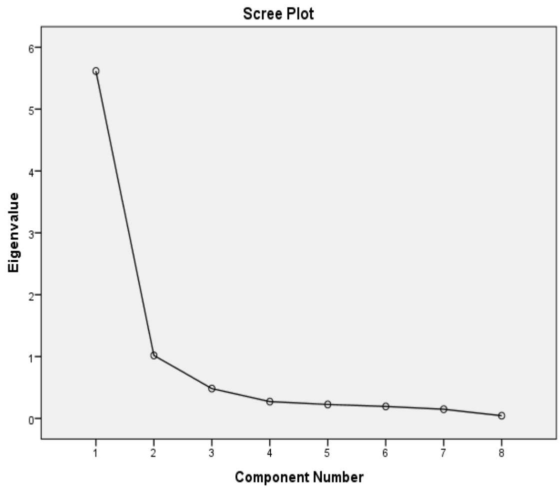
Table 11 presents the items segregated under 4 factors. Some cross-loadings can be observed. Thus, the factor with a higher correlation was selected to keep the item. Herein CK1 to CK3 and PI1 to PI3 are placed under factor 1, SN1 to SN3 under factor 2, PN1 to PN3 under factor 3, and finally, EC1 to EC3 under factor 4. The allotment of all the factors



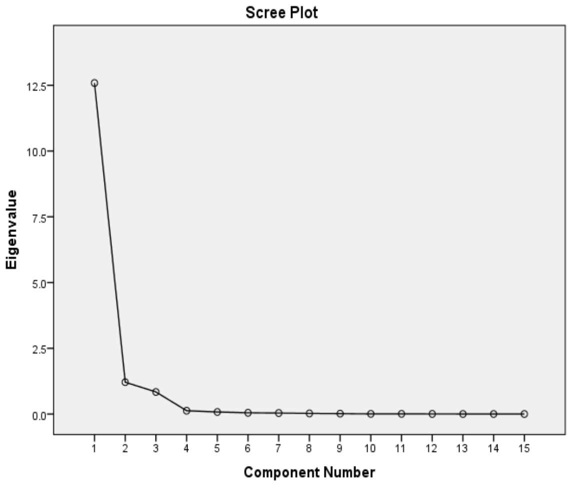
(a)



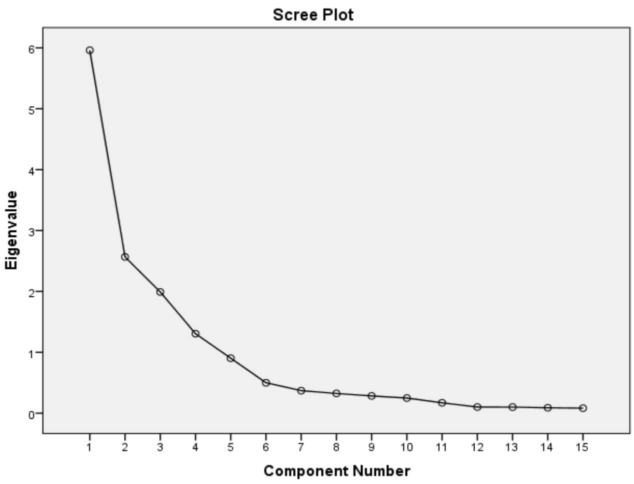
(b)



(c)



(d)



(e)

Fig. 1. Scree Plot for (a) Benefits (b) Challenges (c) Challenges Post Removal of Item C8 (d) Motivation to adopt and (e) Attitude towards adoption of TPU- Based 3D Printed Fashion Clothes

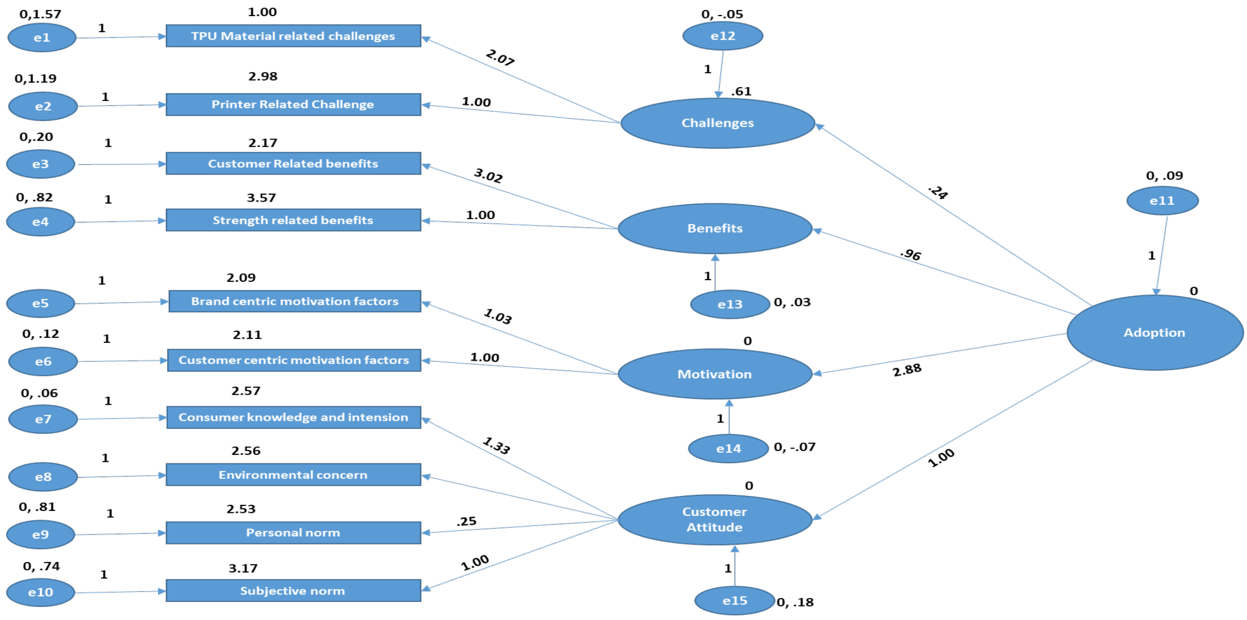


Fig. 2. Proposed Model for Adoption of TPU-Based 3D Printed Fashion Clothes

Chi-Square Statistic Model Fit Indices				
	CMIN	P-Value	CMIN/ df	
Model Fit indices	81.237	0.00	2.621	
Baseline Comparison Model Fit Indices				
	NFI	TLI	CFI	
Model Fit Indices	0.799	0.745	0.856	
FMIN Model Fit Indices				
	FMIN	F0	LO 90	HI90
Model Fit Indices	0.312	0.193	0.105	0.311
RMSEA Model Fit Indices				
	RMSEA	LO 90	HI90	PCLOSE
Model Fit Indices	0.079	0.058	0.100	0.013

Table 12. Model Fit Indices for Exploratory Factor Analysis

is the same as was originally selected by the researcher except for "purchase intention" (PI1 to PI3, Table 24) which was considered as a separate factor by the researchers but after factor analysis, it was found to be grouped with "customer knowledge" (CK1 to CK3, Table 24) that is under factor 1. Thus, factor 1 was named Customer Knowledge and Intention.

Figure 1 presents the Scree Plot of all the above factors.

To assess the association of the above factors on "Adoption of TPU-Based 3D Printed Fashion Clothes" it is imperative to determine the factor structure (model). For doing so, exploratory factor analysis (EFA) has been conducted. EFA will facilitate variable reduction thereby identifying the number of latent constructs and the underlying factor structure of a set of variables.

As per the perception of the researcher, all the above factors might lead to the adoption of TPU- based 3D printed fashion clothes. Thus EFA has been conducted to establish a model for the same based on the factors extracted via factor analysis conducted in previous sections.

5.5. Exploratory Factor Analysis for the adoption of TPU-Based 3D Printed Fashion Clothes

The model thus obtained post exploratory factor analysis has been presented in Figure 2. The analysis of model fit has been conducted as follows.

Minimum discrepancy per degree of freedom (CMIN/DF)< 3 indicates an acceptable fit between the hypothetical model and sample data [24]. Thus, the proposed model of the present research has an acceptable fit based on CMIN/DF (2.621, Table 12).

NFI value between 0.8 and 0.9 is considered to be acceptable [25]. Thus, the NFI value (0.80, Table 12) in the present research makes the proposed model acceptable. Further, a TLI value of more than 0.9 is considered to be a good fit [25] but in the present research, the TLI value is lower (Table 12). Thus, the research has considered other matrices to base the results on. Finally, a CFI value between 0.8 and 0.9 is considered acceptable which is the case with present research as the CFI value obtained is 0.856.

For FMIN Model Fit Indices, the more the value is close to 0, the better the model fit [26]. Since the values of FMIN Model Fit Indices in the present research are close to zero, it points towards a good model fit.

According to MacCallum et al., (1996) [27], the RMSEA value of less than 0.08 is an acceptable fit, thereby making the proposed model in the present research acceptable.

Since all the model fit indices are within acceptable limits, the model can be stated to be a good fit. Thus, the proposed model has been presented in Figure 2.

6. Conclusions

By observing the model fit indices, the model seems to be a good fit with the observed data. Thus, the adoption of the framework on TPU-based 3D printed fashion clothes (Figure 2) has been suggested in the present research. As per the findings of the present research, on a broader spectrum, the adoption of TPU-based 3D printed fashion clothes in China is dependent on challenges and benefits faced by producers along with the motivation of customers and their attitude towards adoption. The study found the challenges faced by producers, which impact the adoption of TPU-based 3D printed fashion clothes to be of two types – namely, TPU material-based challenges and printer-based challenges.

The benefits were also found to be of two types – namely, customer-related benefits and strength-related benefits. The motivation for the customers to adopt TPU-based 3D printed fashion clothes in China was also found to be of two types: brand-centric and customer-centric. Finally, the attitude of customers towards TPU-based 3D printed fashion clothes was of 4 types – namely, subjective norm, personal norm, environmental concern, and customer knowledge and intention. It is imperative to assess the application of this model. Thus, for future research, it is recommended that this model is applied in a real-time market, on a pilot level, to understand its applicability and effectiveness. Furthermore, it is necessary to conduct an assessment of the suitability of TPU for 3D printing and for the textile industry for future research.

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