The 3rd International Conference on Economics and Social Sciences
Innovative models to revive the global economy
October 15-16, 2020
Bucharest University of Economic Studies, Romania

An Exploratory Analysis of the Consumer Resistance Determinants Regarding the Usage of Nanotechnology in Fashion Industry

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DOI: 10.2478/9788395815072-073

Abstract

Nanotechnology and nanoscience have brought attention to the area of experimental innovation and scientific research. This domain also includes nanomaterials which refer to a broad spectrum of physical, chemical, and biological methods which remodelled the fashion industry. The expectations of actual buyers, regarding the clothes that they purchase, improved significantly and they are in a continuous search of items that meet, at the same time, the protection function and that are sustainable for the environment. Nevertheless, in the fashion industry, we remark the resistance of the consumer when it comes to those type of innovations.

The present research aims to investigate the relationship existing among consumer innovation resistance when it comes to the use of nano materials in the fashion industry and the distinct factors of innovation and consumers' characteristics. The present research develops and empirically validates a scale that measures consumer's resistance determinants when it comes to the use of nanomaterials in the fashion industry through exploratory analysis. Confirmatory factor analysis was performed to check the constructs for testing the hypothesized factors and then, a Structural Equation Modelling was designed. Two out of four hypotheses have been supported by the collected data. Perceived risk and relative advantage are recognised as important factors that manage the consumer's resistance to the use of nanomaterials in the fashion industry. The contribution of the actual paper shows that there are very few studies that investigate the potential factors which affect consumer resistance to innovation when it comes to nanomaterials.

Keywords: Consumer Resistance, Innovation, Nanomaterials, Fashion Industry, Exploratory Analysis.

JEL Classification: C38; D01; D12; L67; O31.

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1. Introduction

We are living very difficult times that impose essential changes in our perspective, in our behaviour, in our social, environmental, financial and physical dimensions, so that we can preserve the environment where we live in accordance with the societal, economical and natural laws.

In this respect, there is a necessity at a global and local level to identify new methods of organizing the industrial activity. This aspect connects to the fashion industry, where clothes should be created by combining interdisciplinary techniques and revolutionary materials in order to provide customers innovations that could combine the requirements of a promiscuous audience.

In this way, nanotechnologies and nanoscience were developed, which present superior physical and chemical characteristics as compared to that of usual techniques of producing clothes.

Despite all the benefits that those methods present a resistance of the consumer when it comes to the adoption of those alternatives was remarked. What the present research proposes is to test and to identify potential determinants that cause this type of reaction from the consumers.

In the following a brief review of the existing studies on consumer resistance, followed by exploratory factor analysis and a structural equation model to test the proposed hypotheses were exposed. Discussions and limitations of the research were exposed.

2. Problem Statement

2.1 General Context

The manufacturing process in the fashion industry was revolutionized by the emergences of biomaterials and nanotechnologies that supported the production of composite materials. In this way, the fashion industry was remodelled, without disturbing the aesthetic and functional characteristics, but also considering the environmental dimension.

In our days, nanoscience and nanotechnologies procedures play an essential function in the process of designing and sharing more sustainable and eco-friendly clothes for approaching generations.

Nanoscience and nanotechnology encompass the analysis and functionality of nanoparticles used in the process of producing clothes; particles developed by chemical, biological, engineering, and scientific procedures.

Even if those procedures provide lots of benefits for the consumers, many constraints prevent those products from being accepted as innovations. Among the various reasons that urge consumers to reject nano textiles (clothes made by using nanomaterials or nano procedures) identifies the inherent tendency of the consumers to go for the default option and to reject something novel, because of the limited knowledge, financial constraints, risk aversion, status-quo bias, etc. All these types

of latent variables determine the consumer to manifest something acknowledged, in general terms, as the resistance to innovations.

Therefore, what proposes the present articles is to identify some of the specific factors that determine consumer resistance to the acceptance of the utilization of nanomaterials in the fashion industry.

The existing specialized literature identifies three types of innovations: incremental, radical, and disruptive ones (Schumpeter, 1934). The present study deals with radical innovations. Nanotechnology is expected to transform the existing fashion market, because of its capacity to provide a competitive advantage, being characterized by essential sources of technological, social, and economic changes for the actual society.

The consumer acceptance of radical innovations requires more commitment and encompass psychological efforts, time, risks, and financial costs higher as compared to incremental innovations (Heiskanen et al., 2007). Resistance to change comes as a natural response of the consumers because it is the individual inclination to attempt for consistency and to satisfy the status-quo (Puiu, I. A., 2019; Ram and Sheth, 1989).

The existing literature achieved a distinction between functional and psychological factors that affect consumer resistance behaviour (Antioco and Kleijnen, 2010). Psychological determinants refer to how consumers perceive the innovativeness of nanotechnologies used in the fashion industry. The essential factors that have been recognized by the specialized literature as relevant in the analysis of the consumer behaviour to innovations were attitudes, values, motives, reasons, and consumer's previous exposure to that innovation (Ram, 1987). On the other hand, functional determinants are related to the effect of the innovations on the consumer, that generates resistance behaviour.

According to Ram (1987), functional factors splits into two sections: consumer subordinate context and consumer independent context. The consumer independent context is supposed to create the same type of resistance across all consumers, while the consumer dependent context varies across distinct consumers. Innovation consumer dependent factors affect consumer's decision to adopt novel products, factors like relative advantage, risk, motivation, and expectations for better articles. In what follows, each one of these factors will be detailed and, also, the tested hypotheses stated.

2.2 Factors of Influence

The relative advantage of an innovation, in this case, nanotechnology applied in the process of producing clothes designates the benefits that innovation provides in order to be considered better than an already exiting alternative. The relative advantage could assume multiple applications, from economic and financial gains, health, and social benefits, time saved and perceived utility.

The perceived risk represents an additional dimension in the analysis of innovation resistance behaviour. Distinct types of risk exist, namely, financial, physical, time, social, psychological and performance risks (Cherry and Fraedrich,

2002). Also, expectations for better products variable were used to estimate the inhibitory effect on the adoption of innovations, namely nanotechnologies used in the fashion industry.

Lastly, motivations were the determinants that settle consumer's needs. Motivation comprises inner processes that lead to behaviour adoption.

To identify the existing relationship between consumer's resistance to nanotechnologies used in the fashion industry and the above-discussed dimensions, we asserted four hypotheses based on the innovation resistance models and previous research findings.

3. Aims of the research

In the present research, we considered the relative advantage of clothes made of nanomaterials as the advantage over usual clothes. Based on past research (Hosseini et al., 2016) it is expected that the relative advantage will exhibit a negative influence of consumer resistance to nanotechnologies applied in the fashion industry.

Hypothesis 1: A low level of relative advantage leads to a higher level of consumer resistance to nanotechnologies in the fashion industry.

Regarding the risk dimension the financial, security and physical risks were considered as essential drivers in case of nanotechnologies used in clothing production.

Hypothesis 2: A high level of perceived risk is expected to lead to a high level of consumer resistance to nanotechnologies in the fashion industry.

Based on previous studies (Hosseini et al., 2016) "expectations" variable is supposed to manifest a positive effect on consumer resistance to clothes made using nanotechnologies.

Hypothesis 3: The higher the expectations for clothes made of nanomaterials, the higher the consumer resistance.

Lastly, motivation is expected to manifest a negative effect on the resistance behaviour to nanotechnologies in the fashion industry.

Hypothesis 4: A low level of motivation leads to a high level of resistance to nanotechnologies in the fashion industry.

4. Research Methods

The data for the present study was collected using online platforms. The initial questionnaire comprised 33 items, but because some of the items were not statistically significant, they were omitted from the analysis, only 24 items remaining. The scale contains statements related to clothes made by using nanomaterials. Each variable was measured on a ninth-point Likert scale with anchors of one to indicate "strongly disagree" and ninth to indicate "strongly agree". With the collected data we intend to apply exploratory factor analysis and a structural equation model in order to explain the consumer resistance to innovation behaviour when it comes to wearing clothes made using nanomaterials. The entire analysis

process will be achieved using the R statistical and programming software (R Core Team, 2018).

Table 1. Demographic information's

Item	Classification	No = 185	
		No.	Percentage
Gender	Male	32	17.30%
	Female	153	82.70%
Age	18-25 years old	136	73.51%
	26-35 years old	31	16.80%
	36-45 years old	11	6.00%
	Over 45 years old	7	3.69%
Residence	Urban	139	75.14%
	Rural	46	24.86%
Employed	Yes	76	41.08%
	No	109	58.92%

Source: Author's Calculus

The participants in the study included 185 students from Biology and Chemistry Romanian Universities. Demographic information was listed in the previous table (Table 1). In the gathered sample, there is a preponderance of female respondents (82.70%), individuals aged between 18-25 years (73.51%) from the urban area (75.14%).

5. Findings

5.1 Exploratory Factor Analysis

The first step, in the exploratory factor analysis, intends to investigate the correlations among the items of the questionnaire.

From figure 1 (Figure 1), it could be recognized that most of the values correlate positively, except items I12 and I13 which correlate negatively with the rest of the items. The second step was to apply Bartlett's test of sphericity. Small values of the significance indicated that exploratory factor analysis is applicable to our data.

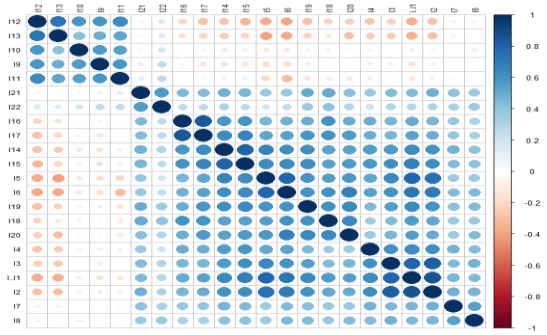

Figure 1. Correlations among Items
Source: Author's Calculus

In the next step, it was applied the Kaiser-Meyer-Olkin-Statistics (KMO) to estimate the appropriateness of the sample to run this type of analysis. The KMO Statistics registered a score of 0.91, considered a marvellous score (Kaiser, 1974).

To determine the suitable number of factors, we used the parallel analysis, performing the fa.parallel function, from the psych (Revelle, 2019) package. From the graphical representation (Figure 2), we could witness a red and a blue line. The red line shows simulated and resembled data, while the blue one show eigenvalues of actual data. The point of inflexion is the position where the gap among simulated and resembled data tends to be at a minimum. In this analysis, five factors were recommended.

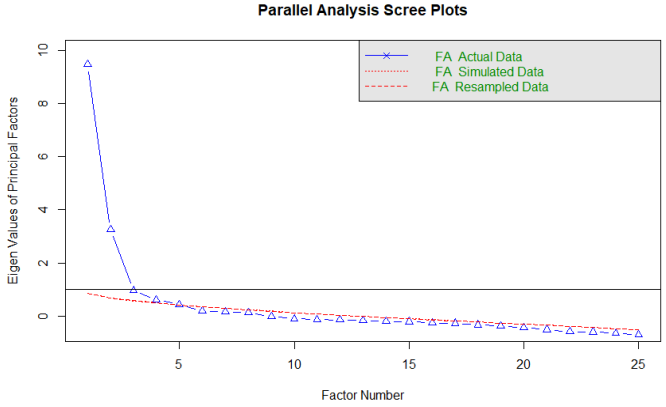

Figure 2. Scree Plot
Source: Author's Calculus

The factoring method used was weighted least squares (WLS), while the factor rotation was oblimin, recommended in the circumstances when the factors are presumed to be correlated. Each of the obtained factors was named depending on the items that it comprises in the following way: relative advantage, consumer resistance, perceived risk, the expectation for better products and motivation.

Table 2. Factors, Items and Loadings

FACTORS	ITEMS	FACTOR LOADING
Relative Advantage (F1)	1. Clothes made of nanomaterials fit with my needs.	**0.822**
	2. Clothes made of nanomaterials fit with my lifestyle/workstyle.	**0.895**
	3. Clothes made of nanomaterials fits with my habits of using clothes.	**0.878**
	4. Clothes made of nanomaterials are a good complement to the traditional clothes.	**0.642**
	5. I need clothes made of nanomaterials for their new features/functions.	**0.601**
	6. I have intentions to use clothes made of nanomaterials soon.	0.456
	7. Clothes made of nanomaterials are more fashionable, stylish, and trendy.	0.405
	8.The price/quality relationship is acceptable in clothes made of nanomaterials.	0.408
Consumer Resistance (F2)	1. Buying clothes made of nanomaterials may be a wastage of money.	**0.619**
	2. I fear of certain changes that clothes made of nanomaterials may impose on me.	0.587
	3. It is unlikely that I buy clothes made of nanomaterials soon.	**0.678**
	4. Clothes with nanomaterials are not for me.	**0.864**
	5. I do not need clothes with nanomaterials.	**0.716**
Perceived Risk (F3)	1. I will wait to buy clothes made of nanomaterials till it proves beneficial for me.	**0.702**
	2. I need to clarify some queries and justify the reasons to buy clothes made of nanomaterials.	**0.671**
	3. I am waiting for the right time to buy clothes made of nanomaterials.	**0.849**
Expectation for Better Products (F4)	1. I expect more secure clothes made of nanomaterials.	**0.760**
	2. I expect more durable clothes made of nanomaterials.	**0.768**
	3. Clothes made of nanomaterials are more convenient, reliable, and useful than normal clothes.	0.401
	4. Clothes made of nanomaterials have a good integration of wide range of functions and services.	0.422
Motivation (F5)	1. I expect more convenient and advanced clothes made of nanomaterials.	**0.656**
	2. It is exciting and entertaining to use clothes made of nanomaterials	0.485
	3. Using clothes made of nanomaterials would be beneficial to environment.	**0.626**
	4. Understanding and using clothes made of nanomaterials may require more skills and or mental effort.	0.452

Source: Author's calculus

As could be observed from the previous table (Table 2), the first factor catches most of the information, being higher than the rest. For all items, the registered loadings that capture the assumed effect of a latent variable and an observed indicator, or broadly speaking, the correlation among them, record scores higher than 0.3.

In terms of adequacy tests, the root mean squared of residuals is desirable to register a value closer to zero, in this case, being 0.03, while the root mean of squared error of approximation registers a score of 0.077, lower than the 0.80 threshold. Regarding the Tucker-Lewis Index of Factoring Reliability, the registered score was 0.894, below the 0.95 cut-off.

For all the obtained dimensions, the Cronbach's Alpha was applied, a measure of internal consistency, which shows how much related are the items of a dimension. In e case of relative advantage, a Cronbach alpha score of 0.92 is registered. The consumer resistance dimension registers a score of 0.87 while the perceived risk dimension has a level of 0.86. The expectation for better product has an alpha score of 0.90 and the motivation dimension registers a Cronbach alpha score of 0.80.

5.2 Confirmatory Factor Analysis

In case of the confirmatory factor analysis, in terms of fit indices, the output revealed slightly good scores for a good fit. The goodness of fit index (GFI) recognised as being like an R2 (Kline, 2016) registers a score of 0.927, below the 0.95 threshold. The adjusted goodness of fit (AGFI) registers a score of 0.91, above the 0.90 threshold (Table 3).

The normed fit index (NFI) analyses the discrepancy among the chi-square value of the null model and the chi-squared value of the hypothesized model (Bentler and Bonett, 1980), a value greater than 0.95 being desirable. In the present analysis it records a value of 0.799 (Table 3). The Tucker-Lewis Index measures the goodness of fit considering the size of correlations in data and the number of parameters in the model. This one registers a value of 0.837 (Table 3).

The comparative fit index (CFI) registers a value of 0.857. The root mean square error of approximation (RMSEA) registers a value of 0.102, a score lower than 0.80 being desirable, while the standardized root mean square residuals (SRMR) registers a value of 0.085 (Table 3.).

Table 3. Fit Indices for Confirmatory Factor Analysis (CFA)

MEASURE	NAME	VALUE	CUT-OFF
A(GFI)	(Adjusted) Goodness of Fit	AGFI = 0.902 GFI = 0.927	AGFI I ≥0.90 GFI I ≥0.95
N (NFI) TLI	(Non) Normed Fit Index Tucker-Lewis Index	NNFI (TLI) = 0.837 NFI = 0.799	NNFI ≥ 0.95 NFI ≥ 0.95
CFI	Comparative Fit Index	CFI = 0.857	CFI ≥ 0.90
RMSEA	Root Mean Square Error of Approximation	RMSEA = 0.102	RMSEA < 0.08
SRMR	(Standardized) Square Root Mean Residual	SRMR = 0.085	SRMR < 0.08

Source: Author's calculus

5.3 Structural Equation Modelling

The main aim of the actual research was to determine the existing relationship among consumer resistance to nanotechnologies in fashion industry and different determinants. In the present case, it is desirable to identify the influence of relative advantage of clothes made using nanomaterials, perceived risk behaviour, expectations for better products and motivation when it comes to the usage of clothes realised with nanomaterials.

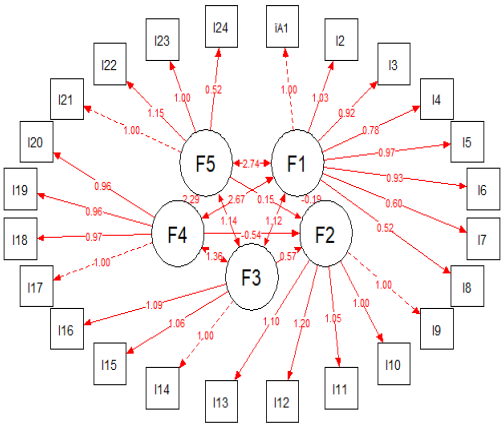

Figure 3. Graphical Format Structural Equation Model
Source: Author's calculus

The performed model revealed that the relative advantage manifests a negative influence on consumer resistance behaviour, and that the influence is not statistically significant (**H_1**: -0.253; p-value = 0.080). Perceived risk exhibits a statistically significant positive influence (**H_2**: 0.668; p-value ~ 0.000), while expectations dimension manifests a negatively statistically significant influence (**H_3**: -0.727; p-value = 0.007). Motivation dimension manifests a positive influence, but the result is not statistically significant (**H_4**: 0.278; p-value = 0.282). The gathered results were listed in the following table (Table 4).

Table 4. Regression Coefficients

Regressions	Estimate	Std. Error	Z-Value	P-Value	Std.lv	Std.all
Consumer Resistance (F2) ~						
Relative Advantage (F1)	**-0.253**	0.144	-1.752	**0.080**	-0.254	-0.254
Perceived Risk (F3)	**0.668**	0.122	5.489	**0.000**	0.537	0.537
Expectation for Better Products (F4)	-0.727	0.271	-2.680	0.007	-0.548	-0.548
Motivation (F5)	0.278	0.258	1.077	0.282	0.221	0.221

Source: Author's calculus

6. Conclusions

The above table (Table 4) showed that only two hypotheses of four were supported (H1: Relative Advantage and H2: Perceived Risk). The acceptance of the relative advantage hypothesis was expected, as scientific literature showed that the relative advantage manifests a negative influence on consumer resistance to innovations (Ram, 1987; Ram & Sheth, 1989).

Therefore, respondents who perceived clothes made of nanotechnologies and nanoscience more favourable than usual clothes, created using standard procedures, manifest a low level of resistance when they are exposed to those innovations.

Similarly, the influence of the perceived risk dimension on the consumer resistance is a negative one. In other words, consumers that perceive clothes made of nanomaterials more risky than usual clothes manifest a high level of resistance. However, the influence does not prove to be statistically significant.

The collected data for the present research do not confirm the hypothesis of H3: Expectations and H4: Motivations. In case of the expectations dimension, a positive influence would be expected, but it proves to be a negative influence, which showed to be statistically significant.

In case of the motivation dimension, it is expected that people with a high level of motivation shall manifest a low level of resistance to nanomaterials. However, the obtained result was not statistically significant, leading to the rejection of the hypothesis.

During this research, we found that consumer resistance when it comes to wearing clothes made of nanomaterials is caused mostly by the relative advantage and the perceived risks. However, other factors should be tested to quantify their influence on resistance behaviour.

As a limit of the present research the convenience sample based on which the study was carried out should be considered, therefore we should keep in mind this aspect when generalizing the results.

Nanotechnology already impacted in a significant way the fashion industry. Thus, a future analysis on consumer perceptions regarding nano textiles, their intentions and actual behaviour would be of interest.

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