Identification and Prioritization of the Factors Influencing the Effectiveness of Nanotechnology in Packaging Industry (Qazvin Province)

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Abstract
Packaging as a component of a product is considered to be an important factor to distinguish the product of different competing companies. Sometimes, packaging functions better than a salesperson because men have emotional, behavioral and mental characteristics in different situations. The use of nanotechnology is increasingly growing in packaging industry. In fact, it comes from the use of basic elements. Each of these basic elements has some special features, the use of which in different field’s exhibits unique properties. In this article, we study the identification and prioritization of the factors influencing the effectiveness of the use of nanotechnology in packaging industry (Qazvin Province). Shannon Entropy method was used to weight the different factors of nanotechnology. Two out of four major data collection instruments were used. Results show that according to the Friedman test, the calculated value is equal to 71.069 which is significant at a freedom degree of 2 and significance level of 0.01. According to the managers, there is significant difference between these factors in terms of effectiveness of nanotechnology, at probability level of 99%.

Keywords: Chemical Protection, Friedman Test, Nanotechnology, Packaging Industry, Physical Protection, Shannon Entropy

1. Introduction
In the recent studies on packaging industry, new subjects such as nanotechnology and ethical marketing have been dealt with. The use of nanotechnology knowledge can improve the quality and efficiency of packaging material. This knowledge has changed packaging industry greatly due to modifying the structure of materials at the molecular level. Therefore, it is essential to identify the important and effective factors in the use of nanotechnology in packaging for the optimal exploitation of its advantages in this industry. The current study aims at finding the answer to these questions, “What are the factors influencing the use of nanotechnology in packaging?” and “How are they prioritized?” As mentioned, packaging has indicated its key role in increasing sales, decreasing inventories, reducing production wastes, and maximizing the profit of manufacturing agencies in national and international dimensions. In this regard, manufacturing units paid due attention to design, graphics, colors, and the use of more appropriate types of special materials. In other words, packaging has had the greatest effect in increasing sales. Considering the extraordinary properties of nanotechnology in today’s world, this branch of science will have an important role in providing food for the current and next generations. Nanotechnology is the most important key to economic potential, business space, especially small and medium ones, and the life standards in the 21st Century. The science of nanotechnology is the ability to gain the control of material in Nano-scale (molecular dimensions) and exploit the features and phenomena of this dimension in materials, tools and modern systems1. Nanotechnology refers to the technique of designing, describing, producing and

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using the structures, tools, and systems in nanoscopic scale. There are three types of packaging in general: Primary packaging is in direct contact with the product. The secondary packaging includes one or more primary packages. The latter is used to group primary packages together and represent the information pertaining to the quality of product. It is usually thrown away when the product is used or consumed. Finally, the third type of packaging includes the previous two types. It is responsible for the distribution, integration and protection of the product during the trade chain. Good packaging of a new product entails decision in several areas. The first step is to create an impression of packaging. It refers to how should packaging be? Or what should packaging do for the product? The second step is to make decisions on other packaging elements such as size, shape, raw materials, color, and business location. In this research articles, we focus to study the following items:

- The requirements of package influence the effectiveness of the use of nanotechnology in packaging (Packaging Industry, Qazvin Province).
- Factors of physical protection influence the effectiveness of the use of nanotechnology in packaging (Packaging Industry, Qazvin Province).
- Factors of chemical protection influence the effectiveness of the use of nanotechnology in packaging (Packaging Industry, Qazvin Province).

2. Methodology

In the current study, Shannon Entropy Method was used to weight the different factors of nanotechnology. Each weight represents the importance of each factor. In the qualitative part of this study, experts were interviewed, whereas a descriptive survey was used in the quantitative part. The use of nanotechnology is one of the most important technological subjects. Given the increasing number of companies and institutions using nanotechnology, the researcher has identified the factors influencing the use of nanotechnology and its effectiveness (Figure 1). In this study, the companies using nanotechnology were first identified, and its effectiveness was evaluated with respect to the reason for using it. Nanotechnology has been used in 4 areas of packaging industry: polymer (organic/inorganic Nano-composites – functional packaging – nanoparticles – smart packages), cellulose, glass, and metals.

2.1 Data Collection Instruments and Methodology

It is quite obvious that the researcher is supposed to investigate the evidence and documents or conduct a library investigation on the subject at the beginning of every study, by which he/she becomes capable of providing an appropriate theoretical framework for the study and ensuring that all influential variables are identified. Besides this information, a questionnaire comprising a set of purposive questions has been used. The questionnaire includes 16 items scored based on a 5-point Likert Scale. Validity of it has been controlled using content validity and face validity methods. Content validity was controlled using Lawshe's formula by 50 collegiate experts. Face validity, which is the understandability of items, was evaluated through the opinions of 35 individuals from the statistical population. The reliability of it was controlled with SPSS after completing 50 questionnaires. Cronbach's alpha was calculated to be between 0.73 and 0.85. As observed, it was smaller than 0.7.

2.2 Statistical Population and Sampling Method

The statistical population included active managers of packaging production companies (almost 280) in Qazvin Province. Moreover, two to eight packaging expert managers were working in each company. Some of the important factories studied in this research included Asan Pack, Polfilm, Shimiane, Peykareh, Pars Packaging, Tehran Baspar Plastic, Moheb, ShayestehSazanMehr Iran, Qazvin Iman Zarf, ArapoushGostar, KavoshgaranePayamAvar, Yeganeh Zarf Sepehr, and Plast Chap Alborz. According to the statistical population, the sampling method used in this study was size-proportional classification because the classes were not equal in size, and the companies had different organizational structure and culture with alternative population percentages.
3. Results and Conclusions

Statistical methods were used to answer research questions and hypotheses, and SPSS was used to analyze data. Out of the questionnaires distributed among the managers and experts of packaging industry, a total number of 76 questionnaires were crossed out due to incorrect completion. However, 224 questionnaires required for statistical analysis were available. The Table 1 indicates the distribution of demographic variables in the sample.

3.1 Inferential Statistics

Spearman’s correlation coefficient was used in this part to analyze and confirm, or refute the hypotheses because data were ranked or ordered.

3.2 The First Hypothesis

The requirements of packaging influence the effectiveness of the use of nanotechnology in packaging industry. Given the value 354 obtained from the following table and significance at confidence level of 99%, the first hypothesis is confirmed (Table 2).

3.3 The Second Hypothesis

Physical protection factors influence the effectiveness of the use of nanotechnology in packaging industry. Given the value 337 obtained from the following table and significance at confidence level of 99%, the second hypothesis is confirmed (Table 3).

3.4 The Third Hypothesis

Factors of chemical protection influence the effectiveness of the use of nanotechnology in packaging industry. Given the value 450 obtained from the following table and significance at confidence level of 99%, the third hypothesis is confirmed (Table 4).

The Friedman test was used at this point to calculate the priorities of factors. According to the Results table, their priorities are as follows: (Chemical Protection) 2.38, (Packaging Requirements) 1.87, and (Physical Protection) 1.75 (Table 5).

On the other hand, the results of the following table, pertaining to the Friedman test, indicate that the calculated value is equal to 71.069 which is significant at a freedom degree of 2 and significance level of 0.01; According to the managers, there is significant difference between these factors in terms of effectiveness of nanotechnology, at probability level of 99% (Table 6).

Table 1. The distribution of demographic variables in the sample

| Variable | Description | Percentage | Cumulative Percentage |
|----------|-------------|------------|-----------------------|
| Gender   | Male        | 66.4       | 66.4                  |
|          | Female      | 33.6       |                       |
|          | Total       | 100        |                       |
| Record   | Low (0-5)   | 33.4       | 33.4                  |
|          | Medium (5-10)| 56.1       | 89.5                  |
|          | High (10-20)| 10.5       | 100                   |
|          | Total       | 100        |                       |
| Age      | Younger than 30 | 20.6       | 20.6                  |
|          | Between 30 and 40 | 46.3       | 66.9                  |
|          | Between 40 and 50 | 18.5       | 85.4                  |
|          | Between 50 and 60 | 10.8       | 96.3                  |
|          | Older than 60 | 3.7        | 100                   |
|          | Total       | 100        |                       |

** Correlation is significant at the 0.01 level (2-tailed).

Table 2. Correlations

| Spearman’s rho Requirements | Physical | Web |
|----------------------------|----------|-----|
| Correlation Coefficient    | 1.000    | .354** |
| Sig. (2-tailed)             | .000     |     |
| N                           | 309      | 309 |

** Correlation is significant at the 0.01 level (2-tailed).

Table 3. Correlations

| Spearman’s rho Physical | Web |
|-------------------------|-----|
| Correlation Coefficient | 1.000 | .337** |
| Sig. (2-tailed)          | .000  |     |
| N                        | 309   | 309 |

** Correlation is significant at the 0.01 level (2-tailed).
4. Conclusions

Due to temporal and financial limitations, the only manufacturers and producers of packaging industry in Qazvin Province were studied, which may limit the generalizability of study results across the country. The lack of relevant studies on nanotechnology and its use in packaging industry, insufficient information on nanotechnology and its use inside the country to benefit from its experiences and relevant results are among other limitations of the current study.

5. References

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Table 4. Correlations

| Chemical Correlation Coefficient | Web Correlation Coefficient |
|----------------------------------|-------------------------------|
| Correlation Coefficient          | .450**                        |
| Sig. (2-tailed)                  | .000                          |
| N                                | 309                           |
| N                                | 309                           |

** Correlation is significant at the 0.01 level (2-tailed).

Table 5. Ranks

| Packaging Requirements | Mean Rank |
|------------------------|-----------|
| Physical Protection    | 1.75      |
| Chemical Protection    | 2.38      |

Table 6. Test Statistics

| Chi-Square | df | Asymp. Sig. |
|------------|----|-------------|
| 71.069     | 2  | .000        |

a. Friedman Test