Original Article

Designing A Model Of Adopting Green Technologies In Iran

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Abstract

The goal of the present study was to design a model of adopting green technologies in Iran. The present study was applied in terms of goal and descriptive-explorative in terms of method. The study method was quantitative-qualitative and was based on the Grounded Theory approach and the structural equation method. The population under study consisted of experts in green technologies. The sampling method was purposive, and hence 8 people were selected. First, using the literature review on technology influence models and green technologies, the variables affecting green technology adoption were determined. Using these data, a quasi-structured interview was conducted to receive expert views. The results of the interviews, obtained from coding the interviews, categorizing the codes, and extracting relations among variables, were used to develop a hypothetical model of adopting green technologies in Iran. Later, using the Delphi method, components were extracted based on the components extracted from the interviews. Coding results indicated that the present study consisted of 6 main categories affecting the influence and success of green technologies in Iranian society. These categories included environmental, economic, cultural, individual, institutional, and social factors. In the quantitative section, statistical analysis results suggested that the factors identified in the literature review and expert views were significantly correlated with green technology success in Iranian society. Public awareness, policy-making, and incentives in the environmental area could leave the highest effects on the success of green technologies in Iran.

Keywords: Green Technologies, Sustainable Development, Public Awareness, Grounded Theory, Structural Equations.

INTRODUCTION

Green technological innovation includes investment in providing green equipment and machinery and the use of advanced green technologies. Also, the development of novel solutions to protect and preserve goods, save material consumption, and document management falls under the green technological innovation category. Green technological innovation is a process of generating technical knowledge aimed at reducing adverse impacts on the environment. Since new technologies leave adverse impacts on the environment and cause irreparable damage to the ecosystem, they may lose their value; for this, organizations are now ready to only invest in new technologies which bring about no such consequences. For this, the concept of an organization's social responsibility becomes clearer (Sholihin et al. 2017).

The technology adoption model (Davis, 1989) was specifically designed to predict a user's adoption of information technology and the extent to which he uses it. Today, this model serves as a powerful and suitable model to predict users' [technology] adoption. According to the technology adoption model, the motive behind using a system is determined by two variables: a level at which an individual believes he can promote his performance using a specific technology, and a level at the individual believes that using a specific technology can be made possible by less effort and more ease. Usefulness and ease of use, derived from the user's attitude towards technology, lead to the motivation to use technology (adoption prediction). Easy-to-use technologies have a positive effect on the user's attitude and motivation to use technology in the future, which will hence increase using technologies.

Nysveen et al. (2005) attempted to integrate various models to better predict a mobile phone technology adoption model and proposed various methods to explain the technology users' motivations. They claimed that the technology adoption model could not be adequate for the technologies used in daily life, as the model should be developed based on the concept of perceived control within the planned behavior theory because there are internal and external limitations in human behaviors not focused on in the technology adoption model. Other studies also confirmed this issue. For example, Teo and Pok's studies (2003) indicated that subjective norms should be considered as a part of the adoption model to use mobile phone technologies. Nysveen et al. developed an integrated model of information system technology adoption which explained the tendency to use mobile phone

technologies. This subject is important because various technologies can help develop various models, which indicate the effects of factors on the increased influence of one specific type of technology. According to Nysveen et al.'s (2005) study, perceived expressiveness, the customers' perception of the pleasure obtained from using technology, technological usefulness for users, the ease of using technology for users, and positive attitudes, among others, were the factors determining how to use mobile phone services. Also, subjective norms and the factors controlling behavior were found to be effective on the consumers' intention to use mobile phone services. As stated above, the present study aimed to design a model of green technology adoption in Iran.

Green technological innovation

Green managerial innovation refers to an organization's capability of developing and implementing green projects, such as green supply chain management and environmental management systems, which enable the organization to achieve its green innovation goals. In this regard, organizations have taken measures including the successful implementation of ISO 14000 Standard Series, saving resource consumption, preventing harmful and hazardous material emissions in the environment, holding seminars to train and promote stakeholders' awareness, etc. (Hens et al. 2018). Green product innovation includes the improvement of the quality and diversity of products by taking into account environmental considerations. The European Union Commission (2001) defines green product innovation as the design and development of products reducing negative and adverse impacts on the environment and mitigating the products' environmental risks; for this, fewer resources are used to produce the products, and wastage production in the stage of product discarding is prevented. Simply put, green innovation in the lifecycle denotes designing a product design to reduce negative environmental impacts. Research results have shown that businesses are nowadays using the green product innovation category (Muawanah et al. 2018).

Sustainable development

In the last two centuries, the environment has been regarded as an external issue and a separate category in human life. According to this perspective, the human-environment relationship is based on the belief that man should live by fully dominating the environment, and it was believed that man had to overcome all environmental barriers by using his intellect and knowledge to bring nature under his control. This perspective also continued with its effects on capitalism development and the industrial revolution of sciences. As suggested by Bacon, one of the leading founders of modern sciences, the world is for mankind, not vice versa (Falamaki, 2002:300). He also argues that man should plan and manage natural resources to prolong this natural wealth. Economics is a science that stresses the relationship between humans and economic growth, and it can be thought of as the key to creating welfare in humans' lives. It is through the economy that poverty and destitution can be eradicated. Development is a key term specifically after the declaration by the United Nations Conference on Environmental Development. On the one hand, development refers to the effort to solve environmental issues and ecological natural sciences and concerns natural preservation. On the other hand, it is the effort to eliminate poverty problems and the economic woes of third-world countries. Sustainable development was raised by the International Union for Conservation of Nature in 1980. The strategy adopted by this Union, i.e., protecting the world, can theoretically contribute to sustainable development. In 1987, World Commission on Environment and Development dubbed (our common future) provided a comprehensive definition of sustainable development, suggesting that man can create sustainable development to meet the present time needs without compromising the capacity of future generations to meet their own needs (Fallah, 2017). Some scholars have defined sustainability to be a kind of future approach, which is a roadmap concentrating on a set of ethical and spatial values. Sustainable development does not enjoy a fixed state of harmony; rather, it involves a changing process, as in mining for investment and technology development strategy, and institutional change compatible with future needs like present needs. Sustainable development is recognized by two determining factors: the concept of primary needs such as food and clothing, which meets basic life needs, and the concept of compatibility between technological demands and social adjustment with the environmental capacity to meet future needs. Various sustainability perspectives in sustainable architecture help resolve challenges in the relationship between creating a comprehensive road to environmental achievements, obtaining a level of quality of life, and economic, cultural, and social values.

Study method

The present study was applied in terms of goal and descriptive-explorative in terms of method. The study method was quantitative-qualitative and was based on the Grounded Theory approach and the structural equation method. The population under study consisted of experts in green technologies. The sampling method was purposive, and hence 8 people were selected. First, using the literature review on technology influence models and green technologies, the variables affecting green technology adoption were determined. Using these data, a quasi-structured interview was conducted to receive expert views. The results of the interviews, obtained from coding the interviews, categorizing the codes, and extracting the relations among the variables, were used to develop a hypothetical model of adopting green technologies in Iran. In the quantitative section, a researcher-made

questionnaire was used to measure study variables, whose validity and reliability was examined. Also, the Kolmogorov-Smirnov Test and Structural Equation Modeling were used.

Findings

According to the qualitative section results, out of the eight samples, 5 people (75%) were males and 3 ones (25%) were females. Thus, most of the statistical population was men. Also, one person (12.5%) was under 35 years, 1 one (12.5%) was between 35-40 years, 3 (37.5%) were between 41-45, and another 3 ones (37.5%) were over 45 years. Out of the eight samples, 2 people (25%) had a record of less than 5 years, 4 ones (50%) had a record of 5-10years, 1 one (12.5%) had a record of 11-15 years, and another one (12.5%) a record of over 15 years.
In the quantitative section, out of the 80 people, 59 (73.8%) were males and 21 (26.2%) were females. Of the 80-people sample, 14 people (17.5%) were under 35, 26 (32.5%) between 35-40, 25 (31.3%) between 41-45, and 15 (18.7%) over 45 years. Of the 380 samples selected, 1 person (1.3%) held associates. 18 (22.5%) B.A., 50 (62.5%) M.A., and 11 (13.7%) Ph.D. Of the 80-people sample, 13 people (16.3%) had a record of less than 5 years, 22 (27.5%) 5-10 years, 26 (32.5%) 11-15 years, and 19 (23.7%) over 15 years.
Primary codes were determined after examining the interviews and primary concepts derived from the interviews, as interview coding was then performed.

Table 1: Theme analysis of the interviews

Goal	Main theme	Secondary themes
Factors affecting the influence and success of green technologies in Iranian society	Environmental	Protecting non-renewable natural resources Using accessible and free resources, such as water, wind, and sun Resources diversification Level of pollution to protect the environment Having a clean environment and protecting it for the future generation Using solar energy for electricity generation
	Economic	Low prices Being economical and cost-saving A percentage for tax exemption Economic effects, negative impacts, removing fossil fuels on the economy Using incentive options Free green technologies Support by governments Low costs Financial and economic rewards
	Cultural	Building culture Encouraging the public to use resources Providing training to use products Support by the providing companies Creating cultural baskets Creating a sense of need across society by getting help from environmental activists and social network influencers Making people aware of green technology advantages Advertising The public use of green technologies Government's giving advantages to the people consuming green technologies Training Using green technologies and turning into a habit Society's higher perception
	Institutional	Failure to create appropriate infrastructure The study and obtaining of statistical data from social networks The high quality of services provided The high quality of equipment provided Longevity by using consumption equipment The lack of need for much space to install the equipment The different provisions of support services Securing factors required for waste segregation by the government Providing conditions to use public transportation or organic foodstuff The lack of resources and the expensiveness of other resources Polling and surveying Increasing technology influence

		Providing the technology as needed Non-complexity The accessibility of retention/ maintenance facilities The volume and level of using green technologies The accessibility of infrastructure in the market Government's support
	Individual	The sense of responsibility-taking against the future generation Education Knowledge about the advantages of these technologies Peoples' attitudes Individual's internal beliefs about using modern technologies Humans' conscience
	Social	The ease of access Public adoption Raising public awareness about the positive effects of using green technologies Individual health Good support for the products The ease of using green technologies The popularity and wide-ranging use of the technologies Usefulness from the view of society Being ethical from the view of society Being prestigious from the view of society The level of conversations in the virtual space about using green technologies

By investigating the themes and the nature of the interviews, common dimensions of the concepts will be revealed in the main themes, a part of which is given in Table (2):

Table 2: Common dimensions of concepts in main themes

Components	**Concepts**	**Identifiers**	**Frequency in interviews**
Environmental factors	Protecting non-renewable and +natural resources Using accessible and free resources, such as water, wind, and sun+ Resources diversification + Level of pollution to protect the environment+ Having a clean environment and protecting it for the future generation+ Using solar energy for electricity generation	A1+A2+A3+A4+A5+A6	4A1+2A2+5A3+5A4+A5+A6
Economic factors	Low prices +Being economical and cost-saving+ A percentage for tax exemption + Economic effects, negative impacts+ of removing fossil fuels on the economy+ Using incentive options+ Free green technologies +	A7+A8+A9+A10+A11+A12+A13+A14+A15	6A7+7A8+2A9+2A10+3A11+4A12+2A13+2A14+3A15

	Support by governments+ Low costs+ Financial and economic rewards		
Cultural factors	Building culture + Encouraging the public to using resources + Providing training to use products + Support by the providing companies + Creating cultural baskets+ Creating the sense of need across society by getting help from environmental activists and social network influencers + Making people aware of green technology advantages + Advertising+ The pubic use of green technologies + Government's giving of advantages to the people consuming green technologies + Training + Using green technologies and turning into a habit+ Society's higher perception	A16+A17+A18+A19+A20+A21+A22+A23+A24+A25+A26+A27+A28	2A16+3A17+8A18+4A19+5A20+6A21+2A22+2A23+3A24+4A25+5A26+6A27+3A28
Institutional factors	Failure to create appropriate infrastructure+ The study and obtaining of statistical data from social networks + The high quality of services provided+ The high quality of equipment provided+ Longevity by using consumption equipment + The lack of need for much space to install the equipment + The different provision of support services + Securing factors required for waste segregation by the government + Providing conditions to use public transportation or organic food stuff+ The lack of resources and the expensiveness of other resources + Polling and surveying+ Increasing technology influence + Providing the technology as needed + Non-complexity + The accessibility of retention maintenance facilities + The volume and level of using green technologies +	A29+A30+A31+A32+A33+A34+A35+A36+A37+A38+A39+A40+A41+A52+A43+A44+A45+A46+	4A29+6A30+3A31+2A32+4A33+5A34+6A35+2A36+3A37+4A38+A39+3A40+A41+5A42+3A43+4A44+5A45+A46+4A47+5A48+3A49+4A50+5A51+3A52

	The accessibility of infrastructure in the market +Government's support		
Individual factors	The sense of responsibility-taking against the future generation + Education+ Knowledge about the advantages of these technologies + Peoples' attitudes+ Individual's internal beliefs about using modern technologies+ Humans' conscience	A47+A48+A49+A50 +A51+A52	5A47+4A48+5A49 +34A50+3A51+A5 23
Social factors	The ease of access + Public adoption + Raising public awareness about the positive effects of using green technologies + Individual health + Good support for the products + The ease of using green technologies+ The popularity and wide-ranging use of the technologies + Usefulness from the view of society + Being ethical from the view of society + Being prestigious from the view of society + The level of conversations in the virtual space about using green technologies	A53+A54+A55+A56 +A57+A58+A59+A6 0+A61+A62+A63	7A53+5A54+6A55 +5A56+4A57+5A5 8+3A59+A60+3A6 1+2A62+3A63

According to the interviews with 8 people, 63 factors were effective in the influence and success of green technologies in Iranian society, each falling in the category of individual, cultural, economic, social, environmental, and institutional categories.

Later, the Delphi method was used to extract components based on the components extracted from the interviews. In the first round, a list of categories, sub-categories, and concepts was provided to experts to comment on them and to confirm or reject them. Also, to correct the model, they were asked to add their theories and suggestions to the model. In the second round, a set of gathered factors, together with the results of the first round, was provided to the second group of experts to determine the significance of each of the categories, subcategories, and concepts. In each stage, the researcher made suggestions for the concepts, subcategories, and concepts. In the end, after the second round of the Delphi method, the categories, subcategories, and concepts that received higher averages from experts were selected.

In the first round of the Delphi method, items 32, 33, 48, 62, and 63 were removed from the questionnaire for having an average of less than 3, with the rest of the items falling in the second round. In the second round, because all the items held an average rate of over 3, there was no need to remove the items anymore. Hence, according to the results of the third round, the most important components affecting the influence and success of green technologies in Iranian society were identified and prioritized.

Table 3: Results from the third-round Delhi method

Components	**Averages**	**SD**	**Average rank**
Protecting non-renewable natural resources	4.37500	.74402	34.94
Using accessible and free resources, such as water, wind, and sun	3.1250	1.88509	26.63
Resources diversification	4.1250	.83452	29.56
Level of pollution to protect the environment	4.0000	.92582	26.31
Having a clean environment and protecting it for the future generation	4.5000	.75593	37.50
Using solar energy for electricity generation	4.2500	.70711	32.44

Low prices	3.6250	1.18773	22.63
Being economical and cost-saving	4.7500	.70711	43.56
A percentage for tax exemption	4.1250	.83542	30.00
Economic effects, negative impacts, removing fossil fuels on the economy	4.0000	.75593	27.06
Using incentive options	4.5000	.53452	36.13
Free green technologies	4.2500	.70711	32.44
Support by governments	4.0000	.75593	25.69
Low costs	4.1250	.83452	29.25
Financial and economic rewards	4.1250	.83452	29.63
Building culture	4.1250	1.12599	32.25
Encouraging the public to use resources	4.2500	.88641	33.13
Providing training to use products	4.3750	.74402	34.31
Support by the providing companies	3.7500	1.28174	26.38
Creating cultural baskets	4.2500	.70711	31.31
Creating a sense of need across society by getting help from environmental activists and social network influencers	3.7500	.70711	22.63
Making people aware of green technology advantages	3.6250	.91613	21.69
Advertising	3.8750	.64087	24.06
The public use of green technologies	4.0000	.92582	27.38
Government's giving advantages to the people consuming green technologies	4.1250	.83452	28.31
Training	3.7500	.70711	22.63
Using green technologies and turning into a habit	4.5000	.75593	37.56
Society's higher perception	4.5000	.75593	36.25
Failure to create appropriate infrastructure	4.2500	.70711	32.00
The study and obtaining of statistical data from social networks	4.3750	.74402	34.56
The high quality of services provided	4.000	.92582	25.81
The lack of need for much space to install the equipment	4.1250	.99103	29.38
The different provisions of support services	4.0000	.92582	25.81
Securing factors required for waste segregation by the government	4.2500	.70711	31.44
Providing conditions to use public transportation or organic foodstuff	4.1250	.64087	29.44
The lack of resources and the expensiveness of other resources	4.3750	.51755	34.44
Polling and surveying	4.2500	.88641	32.56
Increasing technology influence	4.2500	.53452	35.13
Providing the technology as needed	4.2500	.70711	31.44
Non-complexity	4.2500	.53452	36.13
The accessibility of retention/ maintenance facilities	4.2500	.70711	31.44
The volume and level of using green technologies	4.1250	0.64087	28.44
The accessibility of infrastructure in the market	4.1250	.83452	29.56
Government's support	3.8750	.99103	24.94
The sense of responsibility-taking against the future generation	3.3750	1.84681	26.88
Knowledge about the advantages of these technologies	4.5000	.75593	36.25
Peoples' attitudes	4.5000	.75593	26.25
Individual's internal beliefs about using modern technologies	3.8750	.64087	22.69
Humans' conscience	3.5000	.75593	.1688
Public adoption	3.8750	.83452	23.81
Raising public awareness about the positive effects of using green technologies	4.1250	.99103	29.38
Individual health	3.8750	.83452	23.18
Good support for the products	3.7500	1.16496	23.88
The ease of using green technologies	4.1250	.99103	29.94
The popularity and wide-ranging use of the technologies	3.8750	.83452	23.38

Usefulness from the view of society	4.2500	1.03510	33.44
Being ethical from the view of society	4.6250	.74402	38.56

According to coding results, the present study had 6 main categories affecting the influence and success of green technologies in Iranian society. The coding procedure led to several environmental, economic, cultural, individual, institutional, and social factors. According to the interview results, the study model is as follows:

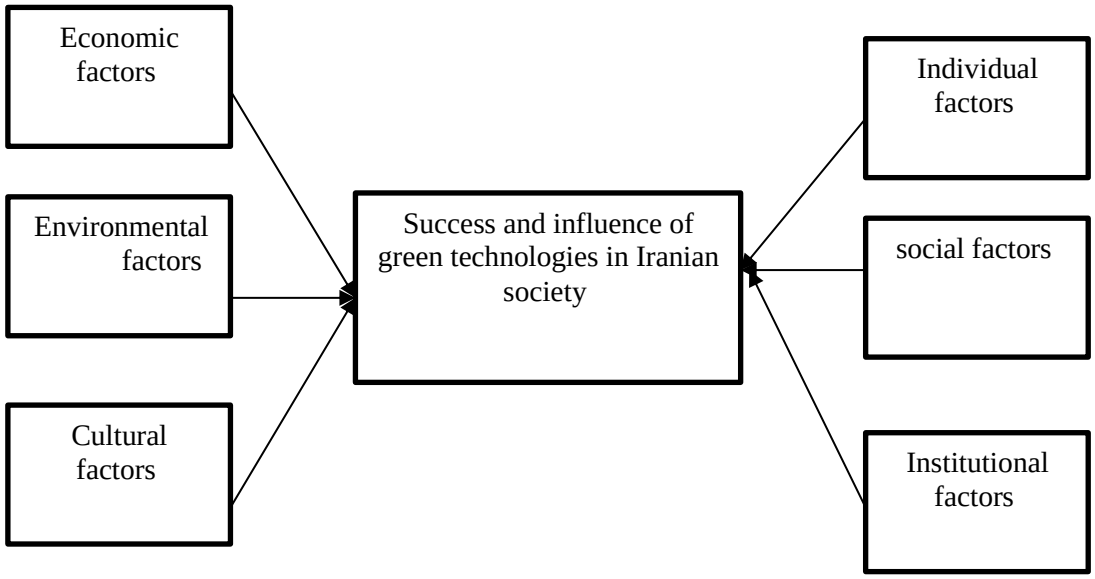

Figure 1: Initial model of the study

The statistical indices of the median, standard deviation, and error percentage (independent and dependent variables) are given below.

Table 3: Describing study variables

	Min.	**Max.**	**Mean**	**SD**	**Variance**	**Kurtosis**	**Skewness**
Environmental factors	3	5	4.1604	0.47619	0.227	0.527-	-0.312
Economic factors	2.44	5	3.9319	0.56087	0.3150/	0.160	0.139
cultural factors	3	5	3.9740	0.50862	0.259	-0.435	0.575
Institutional factors	2.75	5	4.1617	0.46247	0.214	0.270	-0.082
Individual factors	2.60	5	4.1700	0.53353	0.285	0.253	-0.274
social factors	3.44	5	4.4486	0.35642	0.127	0.735	0.840
Success and influence of green technologies in Iranian society	2.80	5	4.2875	0.45656	0.208	0.574	-0.500

A review of the Kolmogorov-Smirnov statistic revealed that the expected distribution was not significantly different from the observed distribution of all variables; thus, these variables were found to be normally distributed.

Table 4: A summary of key factor results

Hypothesis	**Statement**	**Correlation coefficient**	**Coefficient of determination**	**Modified coefficient of determination**	**Determining standard error**
First	Effects of environmental factors on the success of green	0.856	0.734	0.730	0.23717

	technologies in Iranian society				
Second	Effects of economic factors on the success of green technologies in Iranian society	0.509	0.259	0.250	0.39548
Third	Effects of cultural factors on the success of green technologies in Iranian society	0.480	0.231	0.221	0.40299
Fourth	Effects of institutional factors on the success of green technologies in Iranian society	0.551	0.304	0.295	0.38340
Fifth	Effects of individual factors on the success of green technologies in Iranian society	0.499	0.249	0.240	0.39808
Sixth	Effects of social factors on the success of green technologies in Iranian society	0.350	0.123	0.112	0.43035

Conclusion

The goal of the present study was to design a model of adopting green technologies in Iran. In the qualitative section, the relevant literature review was studied to determine the factors affecting the influence and success of green technologies in Iranian society, then using quasi-structured interviews with experts, a hypothetical model of green technology adoption in the society was obtained. According to the coding results, the present study had 6 main categories affecting the influence and success of green technologies in Iranian society. The coding procedure led to the identification of environmental economic, cultural, individual, institutional, and social factors.

In the quantitative section, statistical analysis results indicated that the factors identified in the literature review were significantly related to the success of green technologies in Iranian society. Public awareness, policy-making, and incentives in the environmental area could leave the highest effects on the success of green technologies in Iran.

These results confirm the pivotal role of governments and legal bodies in legislation, strategies, and execution plans to raise awareness and promote environmental standards. Of course, other factors, including economic, cultural, institutional individual, and social factors are critical in this regard and can affect the influence of green technologies. Considering the role of economic factors, low energy processes, and government subsidies, green technologies become economically inappropriate, and therefore one of the key barriers to green technologies in Iranian society under current conditions is the cheap prices of fossil fuels, which eliminate any economic justification for using green technologies.

Also, cultural and institutional factors indicate the role of NGOs and their activities in raising public awareness and laying the ground for the greater use of these technologies. Despite the rich Iranian cultural background of respect for nature, the heterogenous modernization of Iranian society over the past century has made the living patterns of Iranian society less based on regard for environmental factors. Therefore, encouragement by civil bodies to create cultural changes and improve institutional changes could be a step forward. It is clear that by raising public awareness, the positive effects of individual factors on using and adopting green technologies have also increased, and thus using green technologies can be more successful.

Considering the social and cultural diversity of Iranian society and data gathering from metropolises, the findings of this study can be examined in smaller communities such as smaller cities and rural areas.

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