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Planning the priority of high tech industries based on SWARA-WASPAS methodology: The case of the nanotechnology industry in Iran

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Decision-making and planning at the top level is highly complicated. One important duty of each government and of policy makers is planning at different levels for future problems. This research addresses such a concern. Planning for the future is the aim of this research. Moreover, the importance of the topic is discussed. The case study focused on is the nanotechnology industry and its development in Iran. Nanotechnology is one of the main and strategic industries in Iran. The important criteria for such a development are determined based on a literature review and the experiences from other countries. The different alternatives are selected based on the different applications of nanotechnology in other industries. The alternatives are: agriculture, transportation, construction, oil and gas, textile products, food industry, defence industry, health and medicine, nano electronics, nano energy and environment and water. The methodology employed is Multiple Criteria Decision Making (MCDM). In addition, SWARA-WASPAS is the hybrid MADM model employed in which SWARA is applied to evaluate the criteria and WASPAS is utilised to evaluate and rank the alternatives.

Keywords: Future planning; high-tech industries; nanotechnology; Multi Criteria Decision Making (MCDM); SWARA; WASPAS

JEL classification: O14, O25, C44, C63

1. Introduction

In our time, the emergence of knowledge is such that scholars and scientists call it the ‘knowledge era’. In this era, knowledge is seen as the distinctive factor of development or underdevelopment. Nations and communities that recognise the importance of knowledge early can take advantage of knowledge as a strategic factor or competitive benefit in the economic, social, and political forums. Hence these countries could build a considerable and distinctive gap between themselves and other countries (Jannatifard, Nikraftar, & Safdari, 2011).

Nowadays, no country is immune from the influence of technological advances. In recent decades a technological revolution was accompanied by changes in social,

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economic, political and even personal topics around the world. The technological revolution has great potential to metamorphose the quality of life, business and industry evolution, and the wealth and displacement power at the national level. Technology achievements for each country create wealth, power, opportunity, pride and national honour; therefore, nations are enthusiastic to dominate the technology.

Innovative initiatives, especially R&D activities, are the important parts of productivity growth (Griliches, 1981; Sadeghi, Azar, & Sepehri Rad, 2012; Stokey, 1995; Wang & Wu, 2012; Wang, Yu, & Liu, 2013) and since the mid-1990s – at the same time as the information technology revolution – high-tech industries have been playing a significant role in economic development (Griliches & Mairesse, 1984; Lichtenberg, 1992; Nadiri, 1993; Ortega-Argilés, Piva, Potters, & Vivarelli, 2010; Tsai & Wang, 2004; Wang et al., 2013).

Governments have realised that without science and technology they cannot compete in the global markets and they cannot ensure their national security. They have found that their prosperity depends on proper employment of science and technology to meet national needs.

Technology is an increasingly important element of globalisation and of competitiveness. The acceleration of technological changes and the pre-requisites necessary to participate effectively in globalisation are making it more difficult for many developing countries to compete (Dahl man, 2007).

Technology plays an increasingly important role in international affairs. It is increasingly seen as a key component of national power and a driving force for global change. Some authors thus proclaim that technology is the 'new wealth of nations' (Ayres, 1988; Rosenberg, Landau, & Mowery, 1992).

In the contemporary world, wherever science and technology have flourished development has been quick and wherever there has been indifference to science and technology, development has been slow. Nowadays, one of the main factors regarding the power of countries is knowledge.

Economic development is highly related to technological development. It is therefore not surprising that many industrially developing nations follow explicit strategies to increase their technological competence level (Steenhuis & Bruijn, 2005).

The Islamic Republic of Iran (IRI) knowingly views 'knowledge' and its consequent adjustment of 20-year prospects to the year of Vision 2025 (2011) as the emergent impact in this era. Achieving the first rank in Science and Technology in Southwest Asia (Vision 2025, 2011) is considered IRI's most import strategic issue.

To achieve this, Iran needs to consider benefits from various factors that were identified over the long-run and, along with continuous improvement, will guide the country to its final destination.

Considering the importance of immediate access to emerging technologies such as automated manufacturing technology, advanced materials technology, microelectronic technology, biotechnology, nanotechnology, information technology, environmental technology, aerospace technology, and new energy technology, no country can handle its economy without keeping pace with the growth and progress of these technologies. Thus, identification of critical and emerging technologies has a significant role in order to provide various scenarios, strategic planning, policy formulation and technology development strategies for moving from the current state to the target state. On the other hand, the limited resources and facilities of each country necessitates prioritising areas of science and technology to achieve the objectives and mission of plans upstream. The Islamic Republic of Iran, by considering the undeniable impact of emerging technology

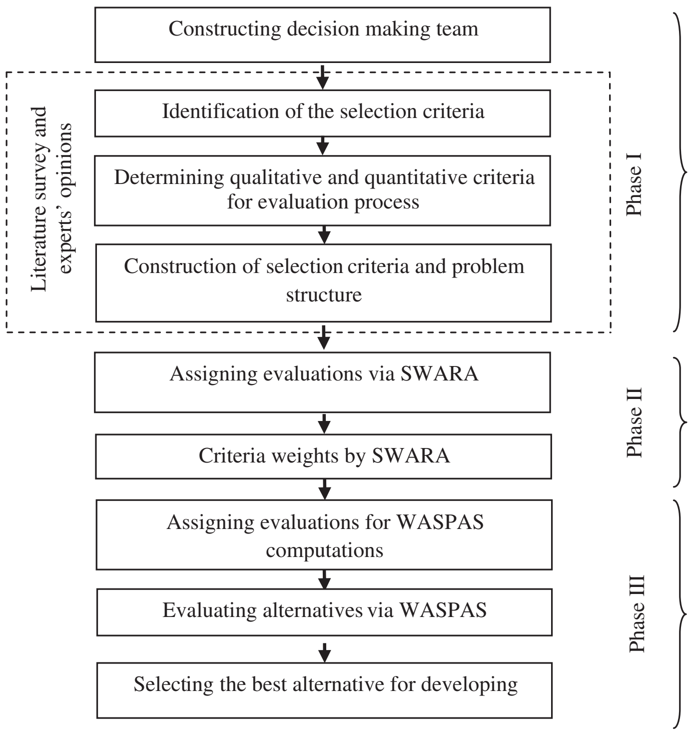

Figure 1. The evaluation procedure. Source: Compiled by the authors

on a nation's wealth and the economy, is paying special attention to it and has initiated a national emerging technology development plan.

In this article, we attempt to develop a methodology for future planning of high tech industries in Iran. The SWARA-WASPAS methodology is applied to the process of decision-making and future planning. The case studied is the nanotechnology industry because nanotechnology has demonstrated excellent progress in Iran.

To this end, all applications of nanotechnology in various areas of sciences in Iran were identified and evaluated using criteria that were determined based on a literature review and past research. SWARA and WASPAS are applied for evaluating criteria and alternatives. The aim is to identify the priority nanotechnology applications that should be investigated.

The evaluation Process of this research is shown in Figure 1.

2. High-tech industries

Technology is an increasingly important element of globalisation and of competitiveness, and the acceleration in the rate of technological change and the pre-requisites necessary to participate effectively in globalisation are making it more difficult for many developing countries to compete (Dahl man, 2007).

Technology plays an increasingly important role in international affairs. It is increasingly seen as a key component of national power and a driving force for global change. Some authors have thus proclaimed technology the 'new wealth of nations' (Ayres, 1988; Rosenberg et al., 1992).

Economic development is highly related to technological development. It is therefore not surprising that many of the industrially developing nations follow explicit strategies to increase their technological competence level (Steenhuis & Bruijn, 2005).

During the current period, the emergence of knowledge is such that scholars and scientists are calling it the "knowledge era'. In this era, knowledge will be considered as a distinctive factor in development or underdevelopment. Nations and communities, who have perceived the importance of knowledge early and taken advantage of knowledge as a strategic factor or competitive benefit in economic, social, and political forums, could build a considerable and distinctive gap between themselves and the other countries (Jannatifard et al., 2011). The Islamic Republic of Iran knowingly views 'knowledge' as the emergent impact in this current era and, consequently, in the country's adjustment of its 20 years prospects, to the year 2025, it considers its most import strategic issue to be achieving the first rank in Science and Technology in Southwest Asia (Vision 2025, 2011).

3. Nanotechnology

Nanotechnology is the manipulation of matter at the atomic and molecular scale. First, an extensive description of nanotechnology refers to the specific goal of precisely manipulating atoms and molecules in order to make macro-scale products, in addition to molecular nanotechnology. A more common definition of Nanotechnology was created by the National Nanotechnology Initiative, which defines it as the manipulation of matter with a minimum dimension sized from 1 to 100 nm. (Drexler, 1986, 1992)

Nanotechnology affects all materials:

- Ceramics
- Metals
- Polymers
- Biomaterials
- Semiconductors

Nanotechnology is an interdisciplinary field that aims to achieve a mass application by 2020. This field is a new approach to education, innovation, learning and management that creates fundamental changes in many aspects of human life.

Nanotechnology will have enormous impact on our lives, production, exchange and communication with others, manufacturing and utilisation of new energy sources and environmental protection.

In the coming decade, it will be necessary to focus on four aspects of nanotechnology development:

(1) How nanotechnology can help to improve our understanding of nature, perform exploration and innovation, predict material properties and design materials and systems at the nano scale, i.e. 'knowledge progress'.
(2) How nanotechnology can create economical and medical values, i.e. 'material progress'.
(3) How nanotechnology is contributing to sustainable development, community safety and international cooperation, i.e. 'global progress'
(4) How nanotechnology can improve quality of life and social justice, i.e. 'moral progress'

Table 1. The experience of nanotechnology strategic plans in some nations (Iran Nanotechnology Initiative Council, www.nano.ir).

Nanotechnology strategic plans

Country	Title	Vision	Priority	Priority Type
Austria	Austrian Nanotechnology Action Plan			
Canada	Alberta Nanotechnology Strategy, Unleashing Alberta's Potential	Alberta will be a leading contributor in placing Canada amongst the top five nations in the world by helping it produce 10 per cent of the world's nanotechnology based economic activity.	Synthesis and characterisation of nanocrystals and nanowires	R & D focus
			Synthesis of materials based on supramolecules	R & D focus
			Production of devices and nanosensors on a molecular scale	R & D focus
			Development of nanomaterials suitable for catalysis and specific modifications to the surfaces of semiconductors	R & D focus
			Development of interfaces for nanoelectronics and nanofluidics devices	R & D focus
			Theory, modelling and simulation of nanosystems	R & D focus
			Development of quantitative imaging and characterisation techniques supporting research into nanotechnology	R & D focus
			Energy and environment	Priority sector
			Health and medical technologies	Priority sector
			Agriculture and forestry	Priority sector
Denmark	Technology Foresight on Danish Nanoscience and Nanotechnology	Towards 2020, Denmark is to be amongst the absolute world leaders in regards to the mastery	Nanomedicine and drug delivery	National priority

(*Continued*)

Table 1. (*Continued*).

Nanotechnology strategic plans				
Country	Title	Vision	Priority	Priority Type
		of nanotechnology within selected areas and its translation into industrial application, increased growth and employment, and solutions for important societal needs.	Biocompatible materials	National priority
			Nanosensors and nanofluidics	National priority
			Plastic electronics	National priority
			Nano-optics and nanophotonics	National priority
			Nanocatalysis, hydrogen technology, etc.	National priority
			Nanomaterials with new functional properties	National priority
Finland	FinNano, Nanotechnology Programme	The FinNano programme will strengthen Finland's position as an innovative high-tech country, Commercialisation of nanotechnology-enabled innovations will increase the welfare of our society	Innovative nanostructure materials	R & D focus
			Nanosensors and nanoactuators	R & D focus
			New nanoelectronics solutions	R & D focus
			Nanostructured and functional materials	R & D focus
			Coatings and devices	R & D focus
			Measurement methods	R & D focus
			Production and scalability	R & D focus
			Electronics	Priority sector
			Forest cluster	Priority sector

		Chemical sector	Priority sector
		Health and well-being	Priority sector
		Environment	Priority sector
		Safety	Priority sector
		Renewal of industry clusters and production	Priority sector
Germany	Action Plan Nanotechnology 2015	Nanochemistry	R & D focus
		Nano-optics and lighting technologies	R & D focus
		Nano-analytics	R & D focus
		Nanobiotechnology	R & D focus
		Climate/energy	Global challenges
		Health/nutrition and agriculture	Global challenges
		Mobility	Global challenges
		Communications	Global challenges
		Security	Global challenges
Ireland	Ireland's Nanotechnology Commercialisation Framework	Advanced materials	R & D focus
		Nanobiotech	R & D focus
		More than Moore	R & D focus

(*Continued*)

Table 1. (*Continued*).

Nanotechnology strategic plans				
Country	Title	Vision	Priority	Priority Type
			Next-gen electronics	Priority sector
			Medical devices and diagnostics	Priority sector
			Environmental applications	Priority sector
Netherlands	Netherlands Nano Initiative, Strategic Research Agenda		Bionanotechnology	National priority
			Nanomaterials	National priority
			Nanofabrication	National priority
			Beyond Moore	National priority
			Water	Priority sector
			Energy	Priority sector
			Nutrition	Priority sector
Norway	Nanotechnology and New Materials (NANOMAT)	Norway shall be a leading research nation in selected fields of nanoscience, nanotechnology and new materials. NANOMAT shall lay the foundations for a new, knowledge-based and research-intensive industrial sector and facilitate a sustainable renewal of established Norwegian industry.	Materials	R & D focus
			Interface/surface science and catalysis	R & D focus
			Fundamental physical and chemical phenomena and processes at the nanometre scale	R & D focus
			Components, systems and complex processes on the basis of N&N	R & D focus
			Ethical, legal and societal aspects	R & D focus

			Synthesis, manipulation and fabrication; characterisation; theory and modelling	R & D focus
			Energy and the environment	Priority sector
			ICT and microsystems	Priority sector
			Health and biotechnology	Priority sector
			Ocean and food	Priority sector
Poland	Strategy for the Reinforcement of Polish Research and Development Area in the Field of Nanosciences and Nanotechnologies		Nanoscale phenomena and processes	National priority
			Nanomaterials and nanocomposites	National priority
			Nanoscale devices	National priority
			Nanoanalytics and nanometrology	National priority
			Manufacturing processes and devices for nanotechnology	National priority
			Development of research systems and implementations in the field of nanotechnology	National priority
Saudi Arabia	Strategic Priorities for Nanotechnology Programme	To create a multidisciplinary programme leveraging all branches of science in order to build competence and capability in nanotechnologies that will help to ensure the future competitiveness of the Kingdom.	Quantum structures and nanodevices	R & D focus
			Synthesis and characterisation of nanomaterials	R & D focus
			Modelling and computations of nanostructures	R & D focus
South Africa	The National Nanotechnology Strategy	To draw upon the existing strengths of the national system of innovation while addressing the need to enhance its research infrastructure and to create a workforce for advanced	Poverty reduction	National priority
			Key technology platforms (including biotechnology and ICT)	National priority

(*Continued*)

Table 1. (*Continued*).

Nanotechnology strategic plans				
Country	Title	Vision	Priority	Priority Type
		technology businesses that support the country's future competitiveness and enhanced quality of life.	Chemical and bio-processing	National priority
			Advanced materials and manufacturing	National priority
			Leveraging resource-based industries	National priority
			Water	Priority sector
			Energy	Priority sector
			Mining and Minerals	Priority sector
			Health	Priority sector
Switzerland	Action Plan: Synthetic Nanomaterials			
UK	UK Nanotechnologies Strategy, Small Technologies, Great Opportunities	The UK's economy and consumers will benefit from the development of nanotechnologies through Government's support of innovation and promotion of the use of these emerging and enabling technologies in a safe, responsible and sustainable way reflecting the needs of the public, industry and academia.	High Aspect Ratio Nanoparticles (HARNs)	R & D focus
			Energy generation through solar technology	National priority
			Novel methods for diagnosing disease and drug delivery	National priority
			Reducing carbon emissions	National priority
			Nanosilver	Priority sector
			Metal oxides	Priority sector
USA	National Nanotechnology Initiative Strategic Plan	A future in which the ability to understand and control matter at the nanoscale leads to a revolution in technology and industry that benefits society	Fundamental nanoscale phenomena and processes	National priority
			Nanomaterials	National priority

Nanoscale devices and systems	National priority
Instrumentation research, metrology and standards for nanotechnology	National priority
Nanomanufacturing	National priority
Major research facilities and instrumentation acquisition	National priority
Environment, health and safety	National priority
Education and societal dimensions	National priority

Country	Reference	Reference (pdf)
Austria	http://www.statnano.com/index.php?ctrl=document&action=view&lang=2&id=12	
Canada	http://www.statnano.com/index.php?ctrl=document&action=view&lang=2&id=11	http://www.assembly.*ab*.ca/lao/library/egovdocs/2007/alae/162023.pdf
Denmark	http://www.statnano.com/index.php?ctrl=document&action=view&lang=2&id=6	
Finland	http://www.statnano.com/index.php?ctrl=document&action=view&lang=2&id=16	
Germany	http://www.statnano.com/index.php?ctrl=document&action=view&lang=2&id=5	http://www.bmbf.de/pub/akionsplan_nanotechnologie_2015_en.pdf
Ireland	http://www.statnano.com/index.php?ctrl=document&action=view&lang=2&id=17	
Netherlands	http://www.statnano.com/index.php?ctrl=document&action=view&lang=2&id=7	http://www.nanoned.nl/downloads/downloads/Netherland_Nano_Initiative_SRA_English.pdf

(*Continued*)

Table 1. (*Continued*).

Nanotechnology strategic plans

Country	Reference	Reference (pdf)
Norway	http://www.statnano.com/index.php?ctrl=document&action=view&lang=2&id=18	NANOMATprogramplanengelskweb.pdf
Poland	http://www.statnano.com/index.php?ctrl=document&action=view&lang=2&id=14	
Saudi Arabia	http://www.statnano.com/index.php?ctrl=document&action=view&lang=2&id=8	http://www.kacst.edu.sa/en/research/Documents/Nanotechnology.pdf
South Africa	http://www.statnano.com/index.php?ctrl=document&action=view&lang=2&id=9	
Switzerland	http://www.statnano.com/index.php?ctrl=document&action=view&lang=2&id=15	Action+plan+Synthetic+Nanomaterials.pdf
UK	http://www.statnano.com/index.php?ctrl=document&action=view&lang=2&id=4	http://www.bis.gov.uk/assets/goscience/docs/u/10-825-uk-nanotechnologies-strategy.pdf
USA	http://www.statnano.com/index.php?ctrl=document&action=view&lang=2&id=3	http://www.nano.gov/sites/default/files/pub_resource/2011_strategic_plan.pdf

Source: Compiled by the authors

During the last few decades, nanotechnology has gained the attention of international scientific and industrial communities. In this regard, nations have launched their short- and long-term programmes to benefit from the huge market expected to be created by the utilisation and implementation of this technology in their industrial/technological infrastructures (Sarkar & Beitollahi, 2009). Some experiences of countries are presented in Table 1. Information was gathered by the authors from information on the Iran Nanotechnology Initiative Council's website.

4. Methodology

The hybrid MCDM method considered in this research is based on the methodology of Hashemkhani Zolfani, Aghdaie, Derakhti, Zavadskas, and Morshed Varzandeh (2013). SWARA-WASPAS is presented at the first step for decision-making on business issues. This methodology is established with a new perspective on decision-making and was developed in other researches, such as assessing the priority of regions for implementing solar plants (Vafaeipour, Hashemkhani Zolfani, Morshed Varzandeh, Derakhti, & Keshavarz, 2014) and evaluating real-time intelligent sensors for structural health monitoring of bridges (Bitarafan, Hashemkhani Zolfani, Lale Arefi, Zavadskas, & Mahmoudzadeh, 2014). This methodology aims for the top level of decision-making and policy-making in the real world.

4.1. Step-wise weight assessment ratio analysis (SWARA) method

There have been several MADM methods, such as the analytic hierarchy process (AHP) (Saaty, 1980), analytic network process (ANP) (Saaty & Vargas, 2001), entropy (Shannon, 1948; Sušinskas, Zavadskas, & Turskis, 2011; Keršulienė & Turskis, 2011), FARE (Ginevicius, 2011), SWARA (Keršulienė, Zavadskas, & Turskis, 2010), etc., in dealing with the multiple criteria problems. In all of the above-mentioned methods, weight assessment is one of the crucial and controversial issues. In most MADM problems, in the process of ranking the alternatives in a decision-making process, a method or an approach is required to calculate the weight of criteria to follow further steps and finally rank the alternatives. Moreover, the final order of alternatives can be calculated in some weight calculation techniques applied for ranking, while in the others it cannot.

Experts' viewpoints are the major determinant of the SWARA method. To be more precise, each expert chooses the importance of each criterion. In the next step, all the criteria are ranked from the first to last, based on each expert's idea. Experts 'opinions, their own implicit knowledge, information and experiences are applied in all evaluation processes. The most important and influencing criterion gets the first rank, and the least important criterion gets the last rank. To determine the overall ranks of the decision model, the mediocre value of ranks is used (Kersuliene & Turskis, 2011). The experts' ability and mastery are the most vital and influencing points in determining the importance of each criterion in the SWARA method (Kersuliene et al., 2010).

The fundamental feature of this method of decision-making is that there is no need to evaluate and rank the criteria since the policies of companies or countries are utilised to define some problems' priorities. Hence, SWARA can be useful whenever the priorities exist but the weight of each criterion is pivotal. SWARA's framework is totally different from other similar methodologies such as FARE, AHP and ANP. SWARA prepares this opportunity in which policy makers make decisions based on different situations and prioritise criteria based on their needs and goals. The other important point is

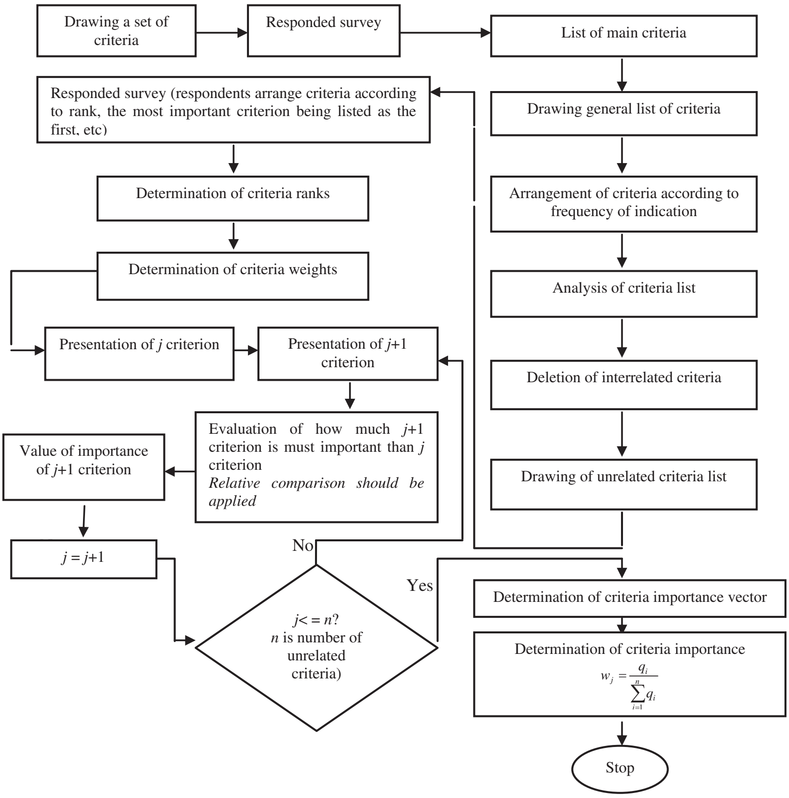

Figure 2. Determining of the criteria weights based on SWARA.
Source: Keršulienė et al. (2010).

the role of experts. Experts play a key role in the process of every important project. The SWARA method is useful to apply in the process of decision and policy-making at the top level of decision-making in important topics (Hashemkhani Zolfani & Saparauskas, 2013).

In the following, some of the recent developments of decision-making models based on the SWARA method are listed: the design of products (Hashemkhani Zolfani, Zavadskas, & Turskis, 2013), selecting the optimal alternative of mechanical longitudinal ventilation of tunnel pollutants (Hashemkhani Zolfani, Esfahani, Bitarafan, Zavadskas, & Lale Arefi, 2013), investigating the success factors of online games based on explorers (Hashemkhani Zolfani, Farrokhzad, & Turskis, 2013), machine tool selection (Aghdaie, Hashemkhani Zolfani, & Zavadskas, 2013a), market segmentation and selection (Aghdaie, Hashemkhani Zolfani, & Zavadskas, 2013b) and sustainable development of rural areas' building structures based on local climate (Hashemkhani Zolfani & Zavadskas, 2013).

The procedure for the criteria weights determination is presented in Figure 2.

4.2. Weighted Aggregates Sum Product Assessment (WASPAS)

WASPAS is a recently presented method and is known as one of the newest methods proposed by the scientific community. This new methodology is based on the Weighted

Sum Model (WSM) and Weighted Product Model (WPM). Zavadskas, Turskis, Antucheviciene, and Zakarevicius (2012) are the innovators of this new method and, in their research, they prove that this aggregated method gets the better accuracy compared with the accuracy of applying just one of WSM or WPM.

WASPAS calculation is based on the following steps.

4.2.1. Normalised decision-making matrix based on

$$\bar{x}_{ij} = \frac{x_{ij}}{\underset{i}{opt}\, x_{ij}}, \text{ where } i = \overline{1, m};\ j = \overline{1, n} \tag{1}$$

if the optimum value is a maximum

$$\bar{x}_{ij} = \frac{\underset{i}{opt}\, x_{ij}}{x_{ij}}, \text{ where } i = \overline{1, m};\ j = \overline{1, n} \tag{2}$$

if the optimum value is a minimum

4.2.2. Calculating WASPAS weighted and normalised decision-making matrix for the summarising part

$$\bar{\bar{x}}_{ij,sum} = \bar{x}_{ij} q_j, \text{ where } i = \overline{1, m}; j = \overline{1, n} \tag{3}$$

4.2.3. Calculating WASPAS weighted and normalised decision-making matrix for the multiplication part

$$\bar{\bar{x}}_{ij,mult} = \bar{x}_{ij}^{q_j}, \text{ where } i = \overline{1, m}; j = \overline{1, n} \tag{4}$$

4.2.4. Final calculation for evaluating and prioritising alternatives based on

$$WPS_i = 0.5 \sum_{j=1}^{n} \bar{\bar{x}}_{ij} + 0.5 \prod_{j=1}^{n} \bar{\bar{x}}_{ij}, \text{ where } i = \overline{1, m}; j = \overline{1, n} \tag{5}$$

All research based on the WASPAS method up to now are listed in the following.

Zavadskas et al. (2012) developed WASPAS as a new methodology, Staniunas, Medineckiene, Zavadskas, and Kalibatas (2013) used it in the ecological–economical assessment of the modernisation of multi-dwelling houses, Hashemkhani Zolfani, Aghdaie et al. (2013) in decision-making in business issues, Aghdaie, Hashemkhani Zolfani, and Zavadskas (2014) in supplier selection and Chakraborty and Zavadskas (2014) in decision-making in manufacturing.

5. Case study

This study is organised based on the economic position of Iran in international literature. Decisions about high tech industries are highly important in managing a country. Nanotechnology is one of the high tech industries that has made significant progress in Iran in comparison with other industries. This research is organised based on applications of nanotechnology in the sciences. The priority of applications is the main part of this research.

5.1. Iran nanotechnology

Iran has recognised the significance of nanotechnology, as have other pioneering countries, and started its activities in line with the development of the technology. In this regard, and as a first step, a Study Committee for Nanotechnology in Iran began its activities in 2001 and, finally, the Iran Nanotechnology Initiative Council (INIC) was established in the country in 2003.

The Islamic Republic of Iran, by considering the undeniable impact of nanotechnology on its nation's wealth and economy, initiated the national nanotechnology development plan referred to as 'Future Strategy' in 2005 (Sarkar & Beitollahi, 2009).

5.2. Vision

For the materialisation of the 20-year vision plan of the Islamic Republic of Iran (Vision 2025, 2011), the software movement and the improvement of the level, quality and security of people's lives, there are some suggestions as to how Iran can become a developed country in nanotechnology through:

- indigenous and advanced infrastructures and enjoying a higher share of expert human resources;
- effective and constructive internal and international interactions;
- generator of economic added value resulting from nanotechnology;
- competition capability at global level.

5.3. Mission

Iran's mission is to succeed in achieving its proper place among 15 countries that are advanced in nanotechnology and to promote that position in a bid to develop Iran's economy.

5.4. Objectives

- Propel the research activities into the field of nanotechnology.
- Provide experts for the nano industry, scientific and technological institutions.
- Establish a mechanism to promote problem-based research into technology.
- Entrepreneur training.

6. The model of research

The model and important criteria of research is identified based on a literature review of this scientific area. The criteria and sub-criteria are illustrated in Table 2.

Table 2. Attractiveness and feasibility index (Durand, 2003; Keenan, 2003; Klusacek, 2004; Son, Park, Oh, & Yu, 2006).

Feasibility		Attractiveness		
Research and technology potential	Application potential	Research and technological opportunities	Social and environment attractiveness	Economic attractiveness
Compatibility with natural and geographical advantages	Ability to provide financing needed	Dealing with Technologies in outlook	Promotion of social justice and welfare	Wealth creation and economic value
Compatibility with Scientific and technological capabilities (for production, localisation, etc.)	Compatibility with requirements of the law – Legal	Localisation and promote technologies have been transferred	Improving health and quality of life	Improve productivity
Acquisition technology required from foreign bodies	Compatibility with The political and international capabilities	Improvement cycle of science and technology to create and innovation new technologies	Utilisation of renewable energy resources, replacing renewable energy	Development Exports of goods and services based on technology
Compatibility with the institutional structure and science - research networks	Compatibility with The private sector's ability	Promotion Basic Sciences	Promotion human's skills in modern and development societies such as innovation and entrepreneurship	Employment with an emphasis on employing expert human
Compatibility with Human Resources		Merge and form clusters of technology (along with other technologies)		Create international strategic advantage
		Opportunities for international cooperation in science and technology		Market growth (increase market share, particularly at the international level)
		Solve problems of related industries		Development and strengthening private sector
		Strengthen the relationship between industry and universities		

Source: Compiled by the authors

7. Applications of nanotechnology in sciences

In this research, 11 applications of nanotechnology are considered. The applications are presented in Table 3.

Table 3. Applications of nanotechnology in sciences.

	Alternatives	
1	Nanotechnology in Agriculture	A_1
2	Nanotechnology in Transportation	A_2
3	Nanotechnology in Construction	A_3
4	Nanotechnology in Oil and Gas	A_4
5	Nanotechnology in Textile Products	A_5
6	Nanotechnology in the Food Industry	A_6
7	Nanotechnology in Defence Industry	A_7
8	Nanotechnology in Health & Medicine	A_8
9	Nano-Electronics	A_9
10	Nano-Energy	A_{10}
11	Nanotechnology in the Environment and Water	A_{11}

Source: Compiled by the authors

8. Experts' information

Forty experts from different fields participated in this research. Their selection process was based on their professional knowledge in the relevant fields and also general knowledge of nanotechnology in science. The experts were selected based on the advice and suggestions of the Iranian Nanotechnology Society (www.nanosociety-ir.com).

The information about experts is shown in Table 4. It should be considered that experts participated in both parts of the research.

9. Research findings

In this section, the numerical results of SWARA and WASPAS are presented. Priority and weights of criteria are presented in the SWARA results sub-section and priority and ranking alternatives are calculated with the WASPAS method.

9.1. SWARA results

The information about calculations with the SWARA method are shown in Tables 5–12. The final weight of each sub-criterion is presented in the tables.

Table 4. The characteristics of the decision-making experts.

	Gender		Education level		
Field	Male	Female	Bachelor	Master	Doctor
Agriculture	3	1	1	1	2
Transportation	5	0	0	3	2
Construction	2	0	1	1	0
Oil and Gas	5	2	1	2	4
Textile Products	2	1	1	1	1
Food Industry	0	2	0	0	2
Health & Medicine	3	2	1	2	2
Electronics	4	1	1	1	3
Energy	4	0	0	3	1
Environment and Water	3	0	0	1	2

Source: Compiled by the authors

Table 5. Final weights of assessment criteria.

Criterion	Comparative importance of average value s_j	Coefficient $k_j = s_j + 1$	Recalculated weight $w_j = \frac{x_{j-1}}{k_j}$	Weight $q_j = \frac{w_j}{\sum w_j}$
C_2		1	1	0.532
C_1	0.135	1.135	0.882	0.468

Source: Compiled by the authors

Table 6. Final weights of feasibility criteria.

Criterion	Comparative importance of average value s_j	Coefficient $k_j = s_j + 1$	Recalculated weight $w_j = \frac{x_{j-1}}{k_j}$	Weight $q_j = \frac{w_j}{\sum w_j}$	Final weights
C_{1-2}		1	1	0.546	0.256
C_{1-1}	0.12	1.12	0.834	0.464	0.212

Source: Compiled by the authors

Table 7. Final weights of attractiveness criteria.

Criterion	Comparative importance of average value s_j	Coefficient $k_j = s_j + 1$	Recalculated weight $w_j = \frac{x_{j-1}}{k_j}$	Weight $q_j = \frac{w_j}{\sum w_j}$	Final weights
C_{2-3}		1	1	0.385	0.205
C_{2-1}	0.14	1.14	0.878	0.337	0.179
C_{2-2}	0.22	1.22	0.720	0.278	0.148

Source: Compiled by the authors

Table 8. Final weights of research and technology potential criteria.

Criterion	Comparative importance of average value s_j	Coefficient $k_j = s_j + 1$	Recalculated weight $w_j = \frac{x_{j-1}}{k_j}$	Weight $q_j = \frac{w_j}{\sum w_j}$	Final weights
C_{1-1-4}		1	1	0.275	0.059
C_{1-1-2}	0.195	1.195	0.837	0.231	0.048
C_{1-1-3}	0.19	1.19	0.704	0.194	0.042
C_{1-1-1}	0.22	1.22	0.578	0.159	0.033
C_{1-1-5}	0.135	1.135	0.51	0.141	0.030

Source: Compiled by the authors

Table 9. Final weights of application potential criteria.

Criterion	Comparative importance of average value s_j	Coefficient $k_j = s_j + 1$	Recalculated weight $w_j = \frac{x_{j-1}}{k_j}$	Weight $q_j = \frac{w_j}{\sum w_j}$	Final weights
C_{1-2-3}		1	1	0.320	0.081
C_{1-2-2}	0.18	1.18	0.848	0.271	0.07
C_{1-2-4}	0.2	1.2	0.707	0.226	0.058
C_{1-2-1}	0.235	1.235	0.573	0.183	0.047

Source: Compiled by the authors

Table 10. Final weights of research and technological opportunities criteria.

Criterion	Comparative importance of average value s_j	Coefficient $k_j = s_j + 1$	Recalculated weight $w_j = \frac{x_{j-1}}{k_j}$	Weight $q_j = \frac{w_j}{\sum w_j}$	Final weights
C_{2-1-1}		1	1	0.2	0.035
C_{2-1-4}	0.13	1.13	0.885	0.176	0.031
C_{2-1-2}	0.17	1.17	0.757	0.151	0.028
C_{2-1-8}	0.195	1.195	0.634	0.126	0.023
C_{2-1-6}	0.12	1.12	0.567	0.114	0.020
C_{2-1-3}	0.23	1.23	0.461	0.093	0.017
C_{2-1-5}	0.205	1.205	0.383	0.077	0.013
C_{2-1-7}	0.205	1.205	0.318	0.063	0.011

Source: Compiled by the authors

Table 11. Final weights of social and environment attractiveness criteria.

Criterion	Comparative importance of average value s_j	Coefficient $k_j = s_j + 1$	Recalculated weight $w_j = \frac{x_{j-1}}{k_j}$	Weight $q_j = \frac{w_j}{\sum w_j}$	Final weights
C_{2-2-2}		1	1	0.277	0.041
C_{2-2-3}	0.195	1.195	0.837	0.233	0.034
C_{2-2-1}	0.22	1.22	0.687	0.190	0.028
C_{2-2-5}	0.2	1.2	0.573	0.159	0.024
C_{2-2-4}	0.13	1.13	0.508	0.141	0.21

Source: Compiled by the authors

Table 12. Final weights of economic attractiveness.

Criterion	Comparative importance of average value s_j	Coefficient $k_j = s_j + 1$	Recalculated weight $w_j = \frac{x_{j-1}}{k_j}$	Weight $q_j = \frac{w_j}{\sum w_j}$	Final weights
C_{2-3-1}		1	1	0.215	0.044
C_{2-3-4}	0.15	1.15	0.870	0.186	0.039
C_{2-3-3}	0.195	1.195	0.729	0.156	0.032
C_{2-3-6}	0.175	1.175	0.621	0.133	0.027
C_{2-3-7}	0.125	1.125	0.553	0.119	0.024
C_{2-3-5}	0.16	1.16	0.477	0.102	0.021
C_{2-3-2}	0.145	1.145	0.417	0.089	0.018

Source: Compiled by the authors. *s_j is calculated based on average of expert's ideas. The information gained privately from each expert and the scale is based multiples of 5%.

In the first step, the criteria in each level are evaluated by experts. In this survey, each expert prioritises the criteria and sub-criteria of each level and then the lowest average is selected. s_j is based on average of experts' ideas. Hashemkhani Zolfani and Bahrami (2014) explained in detail how the SWARA method can work. They considered multiples of 5% as a scale of evaluation. Experts can express the differentiation of criteria and relative importance of them with this scale which is mentioned above.

The weights of the criteria and sub-criteria are presented separately in Table 13. This table is useful for an appropriate overview on the criteria and model of research.

Table 13. The weights of criteria and sub-criteria of the model.

Criteria and sub-criteria	Final weights
C_1: Feasibility	**0.468**
C_{1-1}: Research and Technology Potential	**0.212**
C_{1-1-1}: Compatibility with natural and geographical advantages	0.033
C_{1-1-2}: Compatibility with Scientific and technological capabilities (for production, localisation, etc.)	0.048
C_{1-1-3}: Acquisition technology required from foreign bodies	0.042
C_{1-1-4}: Compatibility with the institutional structure and science - research networks	0.059
C_{1-1-5}: Compatibility with Human Resources	0.030
C_{1-2}: Attractiveness	**0.256**
C_{1-2-1}: Ability to provide financing needed	0.047
C_{1-2-2}: Compatibility with requirements of the law – Legal	0.07
C_{1-2-3}: Compatibility with The political and international capabilities	0.081
C_{1-2-4}: Compatibility with The private sector's ability	0.058
C_2: Attractiveness	**0.532**
C_{2-1}: Research and Technological Opportunities	**0.179**
C_{2-1-1}: Dealing with Technologies in outlook	0.035
C_{2-1-2}: Localisation and promote technologies have been transferred	0.028
C_{2-1-3}: Improvement Cycle of science and technology to create and innovation new technologies	0.017
C_{2-1-4}: Promotion Basic Sciences	0.031
C_{2-1-5}: Merge and form clusters of technology (along with other technologies)	0.013
C_{2-1-6}: Opportunities for international cooperation in science and technology	0.020
C_{2-1-7}: Solve problems of related industries	0.011
C_{2-1-8}: Strengthen the relationship between industry and universities	0.023
C_{2-2}: Social and Environment Attractiveness	**0.148**
C_{2-2-1}: Promotion of social justice and welfare	0.028
C_{2-2-2}: Improving health and quality of life	0.041
C_{2-2-3}: Compatibility with environment and reduction of environment pollution	0.034
C_{2-2-4}: Utilisation of renewable energy resources, replacing renewable energy	0.021
C_{2-2-5}: Promotion human's skills in modern and development societies such as innovation and entrepreneurship	0.024
C_{2-3}: Economic Attractiveness	**0.205**
C_{2-3-1}: Wealth creation and economic value	0.044
C_{2-3-2}: Improve productivity	0.018
C_{2-3-3}: Development Exports of goods and services based on technology	0.032
C_{2-3-4}: Employment with an emphasis on employing expert human	0.039
C_{2-3-5}: Create international strategic advantage	0.021
C_{2-3-6}: Market growth (increase market share, particularly at the international level)	0.027
C_{2-3-7}: Development and strengthening private sector	0.024

Source: Compiled by the authors

9.2. WASPAS results

The priorities of alternatives about future planning in the nanotechnology industry in Iran is presented in Tables 14–16. The information about alternatives is presented in Table 2.

Based on the WASPAS results, application of Nano Technology in Nano technology in health and medicine is identified as the best alternative for developing and investing in future planning of industry in Iran. The priority of nanotechnology applications is presented in Table 16.

Table 14. Decision-making matrix Decision-making matrix.

	C_{1-1-1} 0.033 Max	C_{1-1-2} 0.048 Max	C_{1-1-3} 0.042 Max	C_{1-1-4} 0.059 Max	C_{1-1-5} 0.03 Max	C_{1-2-1} 0.047 Max	C_{1-2-2} 0.07 Max	C_{1-2-3} 0.081 Max	C_{1-2-4} 0.058 Max	C_{2-1-1} 0.035 Max	C_{2-1-2} 0.028 Max	C_{2-1-3} 0.017 Max	C_{2-1-4} 0.031 Max	C_{2-1-5} 0.013 Max	C_{2-1-6} 0.02 Max
A_1	7	3	5	1	1	1	5	5	1	3	5	3	5	5	5
A_2	7	7	5	5	3	5	7	7	7	5	7	7	9	9	9
A_3	7	7	5	5	5	5	7	7	7	5	7	7	9	9	9
A_4	9	7	3	9	7	9	7	9	7	7	7	9	9	9	9
A_5	5	5	5	3	3	3	7	3	3	3	5	5	5	5	5
A_6	5	7	5	5	5	5	7	5	5	3	5	5	5	5	7
A_7	9	9	9	9	9	7	7	7	7	7	7	9	9	9	9
A_8	9	9	7	9	9	7	7	9	9	9	7	9	9	9	9
A_9	7	7	7	7	9	7	7	7	7	9	7	7	9	9	9
A_{10}	9	7	7	7	5	7	7	7	7	9	7	7	9	9	9
A_{11}	9	7	7	7	5	7	7	7	5	9	7	7	9	9	9
	C_{2-1-7} 0.011 Max	C_{2-1-8} 0.023 Max	C_{2-2-1} 0.028 Max	C_{2-2-2} 0.041 Max	C_{2-2-3} 0.034 Max	C_{2-2-4} 0.021 Max	C_{2-2-5} 0.024 Max	C_{2-3-1} 0.044 Max	C_{2-3-2} 0.018 Max	C_{2-3-3} 0.032 Max	C_{2-3-4} 0.039 Max	C_{2-3-5} 0.021 Max	C_{2-3-6} 0.027 Max	C_{2-3-7} 0.024 Max	
A_1	5	5	9	7	5	7	5	5	9	9	7	3	7	7	
A_2	9	9	9	9	9	9	7	7	9	9	9	5	9	9	
A_3	9	9	9	9	9	9	7	7	9	9	7	5	9	9	
A_4	9	9	9	5	7	9	7	9	9	9	5	7	7	9	
A_5	5	7	7	7	5	5	9	7	7	9	9	3	7	9	
A_6	7	7	7	9	7	5	5	5	7	7	9	3	5	7	
A_7	9	7	5	5	1	9	9	9	7	7	7	7	7	9	
A_8	9	9	9	9	5	7	9	9	9	9	7	7	7	9	
A_9	9	9	7	5	3	7	9	7	7	9	9	7	7	9	
A_{10}	9	9	7	9	9	9	5	7	9	5	5	7	7	5	
A_{11}	9	7	7	9	9	9	5	7	9	5	5	5	7	5	

Source: Compiled by the authors

Table 15. WASPAS normalised decision-making matrix.

	C_{1-1-1} 0.033 Max	C_{1-1-2} 0.048 Max	C_{1-1-3} 0.042 Max	C_{1-1-4} 0.059 Max	C_{1-1-5} 0.03 Max	C_{1-2-1} 0.047 Max	C_{1-2-2} 0.07 Max	C_{1-2-3} 0.081 Max	C_{1-2-4} 0.058 Max	C_{2-1-1} 0.035 Max	C_{2-1-2} 0.028 Max	C_{2-1-3} 0.017 Max	C_{2-1-4} 0.031 Max	C_{2-1-5} 0.013 Max	C_{2-1-6} 0.02 Max
A_1	0.7778	0.3333	0.5556	0.1111	0.1111	0.1111	0.7143	0.5556	0.1111	0.3333	0.7143	0.3333	0.5556	0.5556	0.5556
A_2	0.7778	0.7778	0.5556	0.5556	0.3333	0.5556	1.0000	0.7778	0.7778	0.5556	1.0000	0.7778	1.0000	1.0000	1.0000
A_3	0.7778	0.7778	0.5556	0.5556	0.5556	0.5556	1.0000	0.7778	0.7778	0.5556	1.0000	0.7778	1.0000	1.0000	1.0000
A_4	1.0000	0.7778	0.3333	1.0000	0.7778	1.0000	1.0000	1.0000	0.7778	0.7778	1.0000	1.0000	1.0000	1.0000	1.0000
A_5	0.5556	0.5556	0.5556	0.3333	0.3333	0.3333	1.0000	0.3333	0.3333	0.3333	0.7143	0.5556	0.5556	0.5556	0.5556
A_6	0.5556	0.7778	0.5556	0.5556	0.5556	0.5556	1.0000	0.5556	0.5556	0.3333	0.7143	0.5556	0.5556	0.5556	0.7778
A_7	1.0000	1.0000	1.0000	1.0000	1.0000	0.7778	1.0000	0.7778	0.7778	0.7778	1.0000	1.0000	1.0000	1.0000	1.0000
A_8	1.0000	1.0000	0.7778	1.0000	1.0000	0.7778	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
A_9	0.7778	0.7778	0.7778	0.7778	1.0000	0.7778	1.0000	0.7778	0.7778	1.0000	1.0000	0.7778	1.0000	1.0000	1.0000
A_{10}	1.0000	0.7778	0.7778	0.7778	0.5556	0.7778	1.0000	0.7778	0.7778	1.0000	1.0000	0.7778	1.0000	1.0000	1.0000
A_{11}	1.0000	0.7778	0.7778	0.7778	0.5556	0.7778	1.0000	0.7778	0.5556	1.0000	1.0000	0.7778	1.0000	1.0000	1.0000

	C_{2-1-7} 0.011 Max	C_{2-1-8} 0.023 Max	C_{2-2-1} 0.028 Max	C_{2-2-2} 0.041 Max	C_{2-2-3} 0.034 Max	C_{2-2-4} 0.021 Max	C_{2-2-5} 0.024 Max	C_{2-3-1} 0.044 Max	C_{2-3-2} 0.018 Max	C_{2-3-3} 0.032 Max	C_{2-3-4} 0.039 Max	C_{2-3-5} 0.021 Max	C_{2-3-6} 0.027 Max	C_{2-3-7} 0.024 Max
A_1	0.5556	0.5556	1.0000	0.7778	0.5556	0.7778	0.5556	0.5556	1.0000	1.0000	0.7778	0.4286	0.7778	0.7778
A_2	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	0.7778	0.7778	1.0000	1.0000	1.0000	0.7143	1.0000	1.0000
A_3	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	0.7778	0.7778	1.0000	1.0000	0.7778	0.7143	1.0000	1.0000
A_4	1.0000	1.0000	1.0000	0.5556	0.7778	1.0000	0.7778	1.0000	1.0000	1.0000	0.5556	1.0000	0.7778	1.0000
A_5	0.5556	0.7778	0.7778	0.7778	0.5556	0.5556	1.0000	0.7778	0.7778	1.0000	1.0000	0.4286	0.7778	1.0000
A_6	0.7778	0.7778	0.7778	1.0000	0.7778	0.5556	0.5556	0.5556	0.7778	0.7778	1.0000	0.4286	0.5556	0.7778
A_7	1.0000	0.7778	0.5556	0.5556	0.1111	1.0000	1.0000	1.0000	0.7778	0.7778	0.7778	1.0000	0.7778	1.0000
A_8	1.0000	1.0000	1.0000	1.0000	0.5556	0.7778	1.0000	1.0000	1.0000	1.0000	0.7778	1.0000	0.7778	1.0000
A_9	1.0000	1.0000	0.7778	0.5556	0.3333	0.7778	1.0000	0.7778	0.7778	1.0000	1.0000	1.0000	0.7778	1.0000
A_{10}	1.0000	1.0000	0.7778	1.0000	1.0000	1.0000	0.5556	0.7778	1.0000	0.5556	0.5556	1.0000	0.7778	0.5556
A_{11}	1.0000	0.7778	0.7778	1.0000	1.0000	1.0000	0.5556	0.7778	1.0000	0.5556	0.5556	0.7143	0.7778	0.5556

Source: Compiled by the authors

Table 16. The results of WASPAS.

Alternatives				WSP_i	Ranking
Nanotechnology in agriculture	A_1	0.2676	0.2195	0.4871	11
Nanotechnology in transportation	A_2	0.4119	0.3996	0.8115	7
Nanotechnology in construction	A_3	0.4109	0.4018	0.8127	6
Nanotechnology in oil and gas	A_4	0.4393	0.4271	0.8664	2
Nanotechnology in textile products	A_5	0.3061	0.2822	0.5883	10
Nanotechnology in the food industry	A_6	0.3343	0.3236	0.6578	9
Nanotechnology in defence industry	A_7	0.4291	0.4070	0.8361	3
Nanotechnology in health & medicine	A_8	0.4724	0.4689	0.9413	1
Nano-electronics	A_9	0.4209	0.4123	0.8332	4
Nano-energy	A_{10}	0.4163	0.4090	0.8253	5
Nanotechnology in the environment and water	A_{11}	0.4043	0.3960	0.8002	8

Source: Compiled by the authors

10. Discussion

Thinking about these concepts and some others is intended to provide information on the methods and mechanisms underlying the development of nanotechnology. It is obvious that in realising these methods one needs to travel a long way, and that others (leading countries in science and technology) have passed this way. It should not be expected that one passes this way overnight; it took developed and industrialised countries over 200 to 300 years. However, there are successful examples amongst Southeast Asian countries, such as Korea, China, Taiwan, Singapore, Malaysia, India, and so on, such that despite beginning late, over a period of two or three decades, it is possible they could narrow the technological gap between themselves and industrialised countries.

The experiences of the last two centuries also shows that the economic, military and political authority of countries is based on their mastery of technology. So in the present circumstances, and even within the next few years, Iran's main and important strategy should be mastery over technology. To this end an environment should be created in which new technologies can flourish and an obvious commitment to technological development (as one of the national priorities) should be displayed. Emerging technologies are technologies that are not yet fully commercialised (they are in the early stages of their life cycle), but over the next few years they would be commercialised and it is predicted that their use will increasingly develop.

These technologies will create new industries and existing industries may become outdated. They have the ability to create change in organisations and society. So we should enhance our abilities in these fields with caution and vigilance. In this respect, the fields of automated manufacturing technology, microelectronics, biotechnology, micro-technology (nanotechnology), information technology, advanced materials technology, environmental technology, aerospace technology and the technologies of new energy sources should be prioritised for research and development programmes. And in order to develop new technologies, specific research and development programmes should be formulated and a particular credit should be allocated. The extensive nature of these technologies, their close engagement with existing science and technology and their enormous economic and social impact require long-term planning, and a multi-sectoral approach to policy-making. It has also been developed in most active countries in this area.

In Iran, there is a need for policy makers to develop the technologies to be considered by state officials. Therefore, in the last few years the government has taken steps to develop new technologies by planning and allocating relatively enormous resources. Among these, the developmental strategies of biotechnology, the TAKFA project and the founding of a special committee for nanotechnology are notable.

Health and related issues are vital for each society. A sustainable society that is related to human resources, has a direct relationship to social and economic aspects of sustainability. From the other perspective, the 'health and medicine' industry has good potential to develop and make a profit. Without a doubt, health is one of the top priorities of policies in countries around the world. This is because health is a separate and independent topic from all national and regional policies. Furthermore, as we can see from the results, after health and medicine the other priorities are completely related to the national and reginal policies of Iran. The oil and defence applications of nanotechnology are the top priorities after health and medicine.

In this study, a proper model to identify new technology priorities is proposed that can be generalised to other fields of technology. So we should take an international perspective. For Iran, what is happening in the world today is important and the prospect of globalisation in all programmes and policies should be considered. Today, we have to decide about our future in the world and move toward it through proper planning and priority setting. We must ensure that we are aware of international developments in technology (especially new technology). To this end, creating and developing future research centres in different organisational and national levels should be taken into account.

11. Conclusion

Planning in technologies, and especially high tech industries and their futures, has a key role in the economics of each nation, in the present and in the future. This study aimed to develop a methodology for future planning in this area. Decision and policy-making at the top level of managing is highly complicated and needs appropriate cooperation and coordinating.

The Multiple Criteria Decision Making perspective can be considered as a powerful framework and methodology in this way. This perspective can divide the topic into sub-topics and make the decision-making process easier.

The SWARA method has a powerful and logical perspective for decision and policy-making because priorities have different dimensions, such as politics, culture, and so on. In this study SWARA is applied in the process of decision-making for evaluating the weights and priorities of criteria. WASPAS is a new methodology that is very reliable for calculations. In this study, WASPAS is applied to evaluate and rank alternatives.

This research is based on the Iranian situation in international economics and technology. The main industry that was selected as a case study was nanotechnology and its applications in the sciences. Planning is presented based on the priority of results. Investing priorities should be considered based on the results of Table 15. This new framework can be considered as a framework for future and similar research.

Disclosure statement

No potential conflict of interest was reported by the authors.

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