PROVIDING A CONCEPTUAL MODEL FOR THE INNOVATION STRATEGY BY USING SCENARIO-BASED TECHNOLOGY ROADMAP IN CONTEXT OF SMART LOGISTIC SYSTEM

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ABSTRACT

This paper's main purpose is to provide a conceptual model based on scenario planning and technology roadmap for aiding knowledge-based firms that are comforting uncertainty to formulate their innovation strategy to planning. Asking the opinion of experts and managers of these firms, we tried to consider all environmental uncertainties and technological trends in innovative logistics solutions that marine industry knowledge-based firms are faced with. Academic and practical experts have verified the proposed conceptual model, which tries to consider the required dimensions of innovation strategizing. Employing a qualitative approach, we have used deep interviews with experts and managers of knowledge-based firms in Iran's maritime industry to gather and analyze qualitative data. The model obtained is a conceptual model in time, with the advance of the timing strategy and taking into account the characteristics of market pull (drivers, needs, and perspectives) and the technology push (innovations, enablers, and resources) in the overall Innovation strategy process. In this model, ten innovative logistics solutions as elements of the smart logistic system are defined. This model, given the fact that it has been reviewed by the managers and experts of these companies, as well as all the requirements of the literature, has increased its applicability, along with its learning.

Keywords: Innovation Strategy, Scenario-Based Technology Roadmap, Smart Logistics System, Knowledge-Based Companies, Iranian Marine Industries.

INTRODUCTION

Innovations are essential for the success of companies because the ability to create and exploit innovations has always been a key factor in the success of firms (Hauser et al., 2006). Due to the rapid changes in markets, looking to the future, in addition to being a tool for strategic mapping, is also a functional requirement for firms (Rohrbeck & Schwarz, 2013).

Today, the economic condition is increasingly challenging and complex, forcing firms to compete for new services and products with shorter life cycles. However, new logistics opportunities, purchasing markets and new consumer markets are emerging. In addition, domestic markets need to be capable to withstand with foreign market pressures.

Globalization is characterized as a new trend and paradigm for new solutions in emerging rationalists with competition in new markets and tries to identify and integrate new knowledge. At the same time, new knowledge is being curtailed. In these circumstances, customer needs are often met with specific solutions and require a drastic reduction in products and services life cycles (Mohammadi et al., 2018; Miao et al., 2020). Over the last 50 years or so, the service life cycle has shrunk by an average of 75% (Cooper, 2011).

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Our research design had two major phases. In the first phase, we tried to make our panel experts become much more familiar with the way of how innovation strategy in knowledge-based firms in uncertainty conditions can be formulated and how scenario-based technology road mapping can be employed in this situation. In second phase, we asked stakeholders to check the results and verify them. Therefore, in this research, qualitative tools are widely used for data collection and analysis**.** In this research, the concept of innovation strategy has approached based on Vahs and Berm work, which defines innovation strategy by its four components such as technology strategy, product strategy, process strategy and finally timing strategy. The innovation strategy model obtained is a conceptual model in time, with the advance of the timing strategy and taking into account the characteristics of market pull (drivers, needs and perspectives) and the technology push (Innovations, Enablers, And Resources) in the overall Innovation strategy process begins. As in the scenarios-based technology roadmap models, four layers of market, products, technologies and technological resources strategies in the context of the time frame during the model of innovation strategies process are considered in this model.
Our research design had two major phases. In the first phase, we tried to make our panel experts become much more familiar with the way of how innovation strategy in knowledge-based firms in uncertainty conditions can be formulated and how scenario-based technology road mapping can be employed in this situation. In second phase, we asked stakeholders to check the results and verify them.

Innovation and technology strategy as a functional strategy are known as the key elements of strategic planning of any business (Babaei & Tavakkoli, 2017). Many studies address firm's innovation strategies are affected by different organizational features (Mohmmadi et al., 2018; Miao et al., 2020). Review of the literature shows that a conceptual model which handles many of internal and external organizational features relating with innovation strategy in uncertainty situations has not been implemented with the employing scenario-based technology roadmap. The final model obtained is a conceptual model in time, with the advance of the timing strategy and taking into account the characteristics of market pull (Drivers, Needs and Perspectives) and the technology push (innovations, enablers, and resources) in the overall Innovation strategy process begins. In this model, the competitive advantage comes from considering the external environment and paying attention to internal skills and capabilities, and then the stages of competitive strategy, technology strategy, and gaining competitive advantage over time are emphasized. Reviewing all aspects and considering uncertainty by utilizing the scenario-based technology roadmap tool as well as initiating an innovation strategy with developed processes and technologies along with customer needs and market pull are main achievements of the model marine industries knowledge-based firms (Babaei & Tavakkoli, 2015).

In order to present this model, literature review has been initially conducted on the areas of innovative strategy, innovative logistics new solutions, and the conceptual framework of the roadmap for technology and the relationship between them. Then the research methodology is expressed and the conceptual model of the innovation strategy is expressed with the views of the experts. At the end of the article, the findings and results of the research are discussed.

THEORETICAL FOUNDATIONS AND LITERATURE REVIEW

Innovation Strategy in Companies

In this research, the Vahs and Brom model in 2013 has been used to define the dimensions of innovation strategy. The researchers defined these strategies into four dimensions, including

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technology, product, process, and scheduling strategy. In this model, relationships between different components of the innovation strategy model are considered (Vahs & Brem, 2013). Accordingly, new technologies and processes that are created in the organization can lead to the emergence of new products. Also, created new products can drive the application of new technologies and processes.

This knowledge can be used as new logistic solutions for planning and roadmapping for organizations. In this model, the coherence and integration of different dimensions affecting the companies innovation development is shown in Figure 1.

1. **Technology strategy:** This strategy can be used as a route to define which technologies must be deployed and which must be set aside. This strategy is particularly important because many important innovations in this area guided by technology instead of the market.
2. **Product strategy:** This strategy helps us understand which product is to be used, maintained or discarded. Thus, it becomes clear that there is a strong relationship between product strategies and marketing product policies.
3. **Process strategy:** According to the researchers, this strategy is created by combining product and technology strategies. Process innovations improve quality and reduce costs. Of course, creating new products can also lead to process innovations. Therefore, there is a high degree of coherence between processes within products and technologies.
4. **Timing strategy:** The timing component, along with the other components mentioned earlier, is very important. Because choosing right time to launch a new products and services to markets are very important in innovation strategies. If new products replace old products, it is important that the timing strategy be coordinated by existing products life cycles.

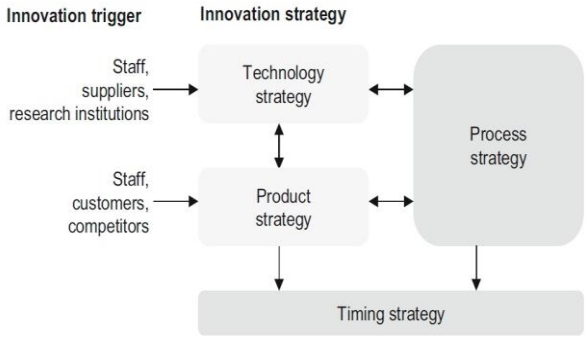

FIGURE 1
INNOVATION STRATEGY COMPONENTS (Vahs & Brem, 2013)

Furthermore, the innovation strategy features are based on the many organizational features and logistic aspects in organizations and it affects them. Among these features are defensive or aggressive behaviour of the organization and whether the organization moves according to the needs of its customers (Market pull) and/or developed technologies (Technology Push) or does the organization roadmap to follow its strategies like logistical strategies based on being a pioneer in the market or being a follower for itself.

Smart Logistics System

Logistics are activities and initiatives to improve customer satisfaction from the planning to distribution (Rukmayadi et al., 2016). Logistics are about processing raw materials includes

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actions to manage the planning, control of production, storage, transportation, and information, between producers and consumers (Fonseca & Vergara, 2015). Smart logistics services in industry 4.0 have an increasingly important role in activities. Nowadays, most companies in using smart logistic system have implemented ICT to increase efficiency and automate their actions. Logistics ensures product availability with quality, timeliness, quantity, on-site, customer-friendly and affordable (Yusianto et al., 2020). Logistic based planning, trace ability is very important for producers, distributors, and consumer (Al-Amri & Al Shammary, 2017). To design an innovation strategy for intelligent logistics and uncertainty conditions is most benefited by advances in the fields of control and sensor RF, robotics and artificial neural networks (ANN), which bring efficiency to the production process (Yusianto et al., 2020). Smart logistics typically use structures with approaches to fuzzy logic, Radio Frequency Identification (RFID), remote sensing, IoT, big data and cloud computing, and mobile applications (Yusianto et al., 2020). Logistics that implement ICT is primarily to improve efficiency, productivity and automate their activities called smart logistic system (Liang & Wang, 2021).

Smart logistic system helps to integrate several goods into one shipment with careful planning. The modernization and industrialization have completed the rapid socio-economic development. In response to efficient global economic trends, a smart logistic system has attracted much attention from the industry and corporates. Smart and modern logistic is a comprehensive system that integrated transport, storage, loading, unloading, packaging, and distribution (Yusianto et al., 2020).

Technology Roadmap Framework

In Figure 2, the general technology roadmap framework based on literature reviews was shown. This multi-layered framework helps to collect data over time and analyze it. In this context, we need to address the questions of where we are going and how. These maps with multi-layered platform help the alignment of interacting context, and absorb assessment on three layers (Saad et al., 2006). The roadmap top layer focuses on understanding the external environment and markets at the macro level. The roadmap middle layer is designed to focus on the appropriate technologies and applications to gain market share. Finally, the roadmap bottom layer also includes the significant resources and infrastructures to reach appropriate products and technologies.

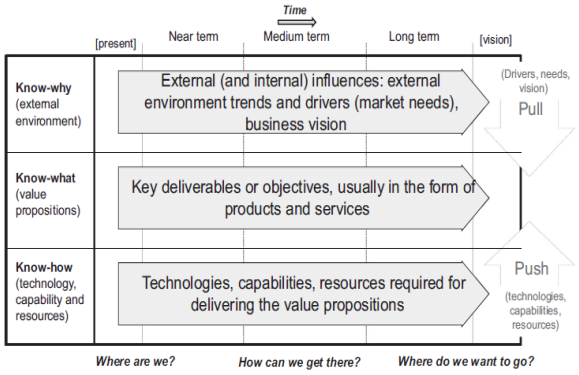

FIGURE 2
THE GENERIC TECHNOLOGY ROADMAP FRAMEWORK (Phaal et al., 2003)

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So, in the framework of the roadmap, the upper layers help to create innovation from the perspective of existing markets, and also the lower layers of the framework help to create innovation with the perspective of pressure of technology (Wells et al., 2004). The roadmap is usually a joint and social process that is done with the participation of experts (Garcia & Bray, 1997). Experts involved in technology road mapping play a key role in designing the roadmapping mechanism (Babaei & Tavakkoli, 2015).

Roadmapping processes are usually accelerating initiatives to drive innovation and entrepreneurship. Sometimes, this is done based on new logistical methods. Therefore, consensus among experts is very important and roadmap developers seek to create mutual understanding (Tsuchiya, 2017), between different experts to increase the likelihood of implementation of the roadmap (Bruce & Fine, 2004; Burgelman & Rosenbloom, 1989).

There is not internationally accepted method for the roadmapping mechanism, just there is a four-step method that researchers can take from the literature (Park et al., 2020). These are (1) initiation and planning, (2) input and analysis, (3) roadmap synthesis and output, and (4) implementation of the roadmap (Ilevbare et al., 2014). The inputs and evaluation phase is usually performed in workshop meetings. In these meetings and forums, the group of experts try to evaluate data to reach consensus among individuals (Kerr & Phaal, 2020).

Technology Roadmap and Innovation Strategy

Simonse et al. (2015) articulated a framework for innovation roadmapping and analyzed its effects on competitive scheduling innovation and industry performance (Simonse et al., 2015; Rinne, 2003) outlines how technology roadmaps can help innovation development and how roadmaps can help managerial functions developments. Also the simultaneous development of technologies and markets can be considered in this framework. A roadmap framework can help develop technologies over time (Rinne, 2003).

Ahlqvist et al. (2012) proposed a roadmap for Innovation Policy (IPRM). A methodological model based on the results of research and development in innovation systems. Thus, IPRM integrates technology and social environment analysis to bring about change, and lists analytical results based on expert opinion for policy design in five steps: (i) creating a common goal and vision; (ii) helping to change the system by social needs analysis and receiving new solutions; (iii) anticipation of new market formation; (iv) understanding the interdependence of roadmap layers; (v) Identify innovation goals in various specialized areas

In structural aspect, the researchers define the IPRM in two contributions. Its initial levels help to roadmappong for System changes, recognizing the development of technologies and designing appropriate socio-economic frameworks to support decisions. Its structure consists of four elements including drivers, policies, regional development and key Enablers. The second level is related to the technology roadmap framework, which is defined based on the vision and macro strategies of the previous levels. According to the study of these researchers, the structure of the technology roadmap, depending on the topics, can have four levels, which are: 1- Technology-based solutions; 2- Enabling technologies; 3-Needs and markets; and 4- Capabilities and resources. The researchers analysed two cases to examine the political perspective of context dynamisms: the green buildings roadmap in Australia and the roadmap of sustainable ICT structures in Finland. Finding of researchers had key conclusions for decision making design: (i) IPRM help to provide useful solutions in creating long-term goals that create a strong network with stakeholders. (ii) Roadmap framework shows the communication between different parts of the system structure (Ahlqvist et al., 2012).

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Scenario-Based Technology Roadmap in Uncertainty

One of the important goals of technology roadmapping tools is to make a functional path to predict the future developments of a markets in terms of uncertainty and examine it in existing trends (Hansen et al., 2016; Kerr & Phaal, 2020). The technology roadmap method has become more popular in recent years compared to many management tools in strategic planning. Its advantages in linking innovations to technologies as well as considering policies and social incentives have been the most important reasons for this popularity (Carvalho et al., 2013; Daim & Oliver, 2008; Garcia & Bray, 1997; Kerr & Phaal, 2020; Lee et al., 2007; Moehrle et al., 2013; Saritas & Aylen, 2010). The visual nature of the roadmap has made this tool different from other tools and has received a lot of attention (Bruce & Fine, 2004; Phaal & Muller, 2009).

Nowadays, Uncertainty in logistics issues is very high, so the technology roadmap method can be very useful in uncertainty situations. Despite the high importance of uncertainties in management functions, but in most roadmapping studies, not enough attention has been paid to this issue. In research of Phaal 650 published roadmap reports (Farrukh & Holgado, 2020; Kerr et al., 2012) were analysed. Their findings show that 64 studies have emphasized the need for uncertainty analysis in the roadmapping. Of these 64 studies, only 22 had few measures to explicitly demonstrate uncertainty. 11 studies have used scenario techniques in Rodmapping. The results also showed that there is an explicit correlation between risk and uncertainty in the structures of roadmap studies. From the literature analysis, it is concluded that this observation of low attention to uncertainty in the roadmap can be extended to planning in the field of innovation management, especially in logistics issues. Therefore, paying attention to the nature of uncertainty and risk in creating a roadmap is very necessary and key (Bromiley et al., 2001; Farrukh & Holgado, 2020).

Previous studies have often been based on texts in different directions(Strauss & Radnor, 2004), but in recent studies, mostly uses graphical tools for planning in different scenarios, and suggests different approaches to achieving specific goals (Lee et al., 2015).

Scenario-base technology roadmapping is a very new approach and attitude in roadmap development, which is a significant analytical power in decision making due to the consideration of different routes. This approach can suggest different decision methods in different scenarios (Lee et al., 2015).

RESEARCH METHODOLOGY

This study is categorized as an applied research and, in terms of research strategy; it is a multiple case study. The case study method can precisely introduce innovation development strategies in marine knowledge based companies by an adequate approach to fully understand the current status (AS-IS). Qualitative case studies allow interpretation based on rich evidence and used to understand less well-known phenomena (Eisenhardt, 1989). In This research, a multidimensional study approach with focus on knowledge based companies analysis of marine industry of Iran is applies. The case study method base on (Yin, 2012) quadruple categorization of case studies is a holistic multiple-case study. By using this approach, different companies from the marine industry, have been studied to present a conceptual model of the innovation strategy in uncertainty with the help of scenario-based technology roadmap.

As mentioned earlier, the focus of study in this research is the marine knowledge based companies in Iran and the research question is to receive to conceptual model of the innovation strategy in uncertainty in that industry. Purposive sampling method is used to select the samples

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and identify the case studies. Purposive sampling which is also known as non-probability sampling, try to select targeted research items for gaining knowledge or information. This type of sampling involves the non-accidental selection of units or research items and cases based on the purpose of the research (Bazeley, 2017). The process of conducting this research is based on the methodology introduced by (Yin, 2012). Which includes the stages of the research plan, case study, data and evidence collection and also data analysis?

Regarding the data gathering in this research, data collection protocol was first developed. Meanwhile, during the reviews and amendments after the initial interviews, the preliminary interview protocol was also formulated. Regarding the data validity, processes such as the selection of key people with careful examination, and the use of initial theoretical framework of research have been used to reach the final model of research. To enhance reliability some techniques were used to organize structured processes for collecting, recording and interpreting data and parallel data analyzing from interviews and agreement among analysts (Qu & Dumay, 2011).

In this study, as it mentioned in Table 1 a deep interview with 6 managers of the marine knowledge based companies was conducted. The basis for the interviews was based on whether is there a systematic way of thinking about issues that allow a company to come up with ideas and break the rules? What kind of strategies should be considered in different areas for companies to create these innovations for companies, and what decisions should be made by companies at the levels of resources, technologies and markets in different scenarios.

Table 1
INTERVIEWS DETAILS AND INFORMATION

No.	Interviewee Position	Gender	Experience in the Industry	Organization	Degree of Education	Interview Date	Interview Duration(h)
1	Manager	Male	38	Saman Pishro Tajhiz	MSc	23th August 2019	00:45:00
2	Manager	Male	32	Caspian Elm Avaran	MSc	25th August 2019	00:55:00
3	Manager	Female	34	Spadana Tarh	MSc	29th August 2019	01:08:00
4	Chief Executive Officer	Male	28	Parsian Tarh Afarinan	MSc	4th September 2019	00:53:00
5	Manager	Male	43	Sepehr System Andish	MSc	13th September 2019	01:45:00
6	Manager	Male	57	Pasargad	PHD	18th September 2019	00:36:00

Interview`s questions were designed based on the main purpose of the study and considering the elementary model of the research. The research findings are obtained based on the analysis of the interviews and the reliance on the collected documents regarding the level of capabilities and experience of Iranian marine knowledge based companies in facing challenges. based on Moore and Benbasat (1991) theory, we consider Convergent Validity (interview construct assessment) and Discriminant Validity (extent to which items referring to different constructs discriminated between them) in our interview administration and analysis. In the final stage of our study, we reported our survey Analyse to marine knowledge-based firms. These

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exchanges provided valuable feedback on the validity of our analysis and its implications for these firms.

FINDINGS

Conceptual Model of the Innovation Strategy

As previously stated, after theoretical studies and interviews with the managers of the Iranian marine knowledge-based companies, the final model of the innovation strategy of these companies was presented taking into account the uncertainty and the help of a scenario-based technology road map tool and smart logistic system structure (Shown in Figure 3).

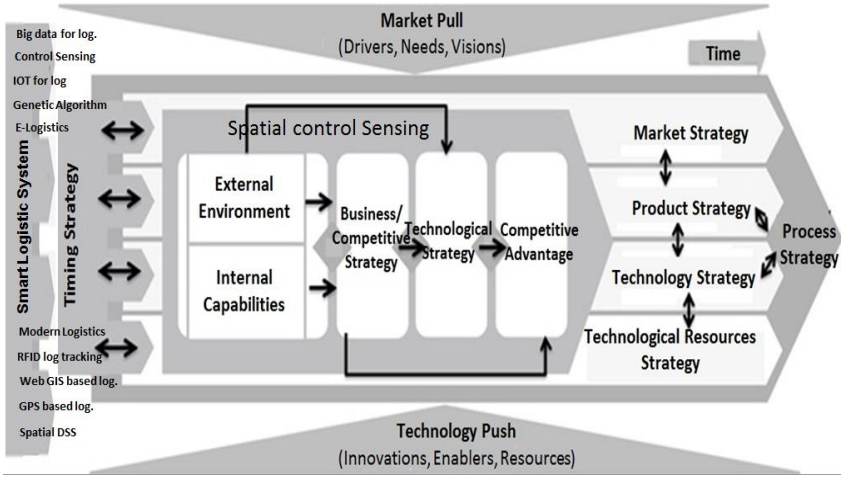

FIGURE 3
THE CONCEPTUAL MODEL OF INNOVATION STRATEGY(OWN 2020)

Market Pull and Technology Push

Attention to the market pull in the innovation strategy of knowledge-based companies in marine industries refer to sustainability innovations that rely on upgrading and optimizing existing products, or adding new functions to meet customer and market requirements (Farrukh & Holgado, 2020).

In this thinking, special attention is required to the main drivers of business, customer needs and the industry's core vision (Tripathy, 2018). The science push approach in the innovation strategy of knowledge base companies, also with regard to fundamental innovations, is trying to apply creativity in the new products development through the science and technology development, and emphasizes on innovations, enablers and resources. Also, for the organization and management of activities, it is possible to use exploration approach (with the aim of further creativity and achieving fundamental innovations) or exploitation approach (with the aim of optimizing and achieving evolutionary innovations) in the structures of these companies.

Of course, the choice between these two approaches is different in designing innovative structures depending on the industry and product context and many other factors but the important note is that relying on one of these two approaches in firm’s structure. This is not appropriate with high turmoil and environmental change.

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Key Strategies (Market, Product, Technology, Technology Resources and Scheduling)

Considering the literature review and studies on the capabilities and challenges facing the knowledge-based industries of Iran, especially in the marine industry, as well as the results of interviews with the managers of knowledge-based companies in the marine industry, which are constantly faced with these challenges, In total, five key strategies and ten new solutions in smart logistic system were considered in the overall framework of the innovation strategy. These strategies include market, product, technology, resources, and timing strategies. These strategies need to be considered throughout the process of innovation strategy. These strategies interaction are shown in particular in the model.

These strategies have been used as key strategies by researchers in the field of innovation and technology. In particular, the literature on the technology roadmap has been developed based on these strategies, the importance of having all of them in the model agreed upon by the managers of knowledge-based companies in the marine industry. Also ten solution in smart logistic system are Big data for logistics, Control Sensing, IOT for logistics, Genetic Algorithm, E-Logistics, Modern Logistics, RFID logistics tracking, Web GIS based logistics, GPS based logistics, Spatial DSS and Spatial control Sensing.

Cultural Barriers

Experts and managers of marine firms have identified cultural barriers as one of the key challenges in attracting new knowledge and innovation development. Adapting the organizational culture and mental readiness of employees in absorbing and exploiting new knowledge can upgrade the technological capabilities of firms in the marine industry. Also, according to the interviewees, the use of knowledge brokers can be very important in increasing the firm ability to absorb and exploit new technological knowledge (Miao et al., 2020). Given the problems of sanctions in Iran, resolving the challenges of international communications and networking with leading companies can be very effective.

From Situation Analysis to Achieve Competitive Advantage

One of the processes that have been specifically addressed at the heart of the corporate innovation strategy model is the process that demonstrates how to achieve competitive advantage by situation analysis. according to this process, as shown in the figure, in the first step, along with market, product, technology, resources and timing strategies, attention is also paid to the requirements of technology push and market pull. This precise knowledge can be an introduction to developing a strategy and preparing a precise business model. Then, based on this business model, technology strategy will be written to achieve distinct competitive advantages. The interaction between these four-step processes is also depicted in this figure.

CONCLUSION

In smart logistic systems, digitization occurs in a standardized way and not as a single business process. Therefore, smart logistics planning in a scenario-based technology roadmap can be accomplished simultaneously with production planning based on data from the previous case. So, with the help of automation, robotics and new methods of processes based on fourth industry revolution, the personnel operation performance in term of uncertainty in environment

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can be increased (Kersten et al., 2017). The experience of presenting innovation strategy model of the knowledge-based enterprises of the maritime industry suggests that commercialization and simultaneous attention to the issue of market pulling are among the main challenges of these companies, and more attention should be paid to them. In this regard, in the obtained model, along with the issues of the science pull, which includes enablers, resources and technologies, special attention has been paid to market strategies, market drivers and market needs.

The time of product presentation and entry into the market is also one of the important points in the strategy of corporate innovation, which has been considered along with timing strategies, should be based on the accurate knowledge of the environment, the recognition of the corporate capabilities and an examination of important indicators, including the market situation, technology life cycle, and so on. Also, along with the above, the development of a competitive strategy and business model for marine knowledge companies based on the accurate knowledge of the internal and external environment and in order to gain competitive advantage has been specifically considered.

In addition to all of the above, developing a time-based innovation strategy reflects the importance of targeting innovations and paying attention to the industry and business perspectives, and it is clear that innovation strategies will also be written to achieve corporate goals. One of the important points highlighted during this study was the careful analysis of the challenges and the presentation of the model, taking into account the requirements of the existing uncertainties.

These uncertainties, which are fundamentally affecting the technological, market, and organizational levels of knowledge-based companies, have made it harder for companies to have a robust and accurate innovation strategy model. These difficult conditions have made the corporate innovation strategy more sophisticated, and try to see all the requirements and key points of these strategies.

One of the weaknesses of this model in the writers' view is the lack of transparency in the path to the type of activity of the innovation strategy, which should be addressed in subsequent studies to overcome this ambiguity. The fact that companies have active behaviours for their innovation, and they are campaigning to eliminate competitors to gain market share or passive behaviour and wait for the competitor to launch a new product and if successful It's a duplicate of copying, two distinct decisions in the strategy of innovation. How to choose these different strategies in the presented model is not stated. Of course, it should be noted that any competitive strategy in the company should show itself in the process and output of the organization, and on the other hand, it is in agreement with the main model of the company strategy.

Studies show that many companies rely on creative actions based on lucrative innovation. Some companies also rely on a particular non-structured approach, which often leads to incremental improvements. The innovation strategy model, which consists of general dimensions, is very necessary for the innovation of companies. This model is a comprehensive, systematic approach that focuses on the creation of incremental, radical and disruptive innovations. Utilizing the above model can make innovations to be a conscious and repeatable process and create an important difference in the value delivered to consumers, customers and partners. The model obtained in this research can be verified in subsequent studies with a higher statistical society of knowledge-based companies in various industries.

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