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A New Stage-by-stage Itemized Model for Assessing Patent Portfolio & Commercialization in Petroleum Incubators

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Highlights

- Identifying several contexts for patent evaluation
- Proposing an itemized model to evaluate patent portfolio
- Proposing the ways to apply the model for real-life cases

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Abstract

Today, Research and Development (R&D) activities in petroleum incubators are of vital importance and it is necessary to investigate different ways of commercializing the patents of these activities. The formulation of petroleum incubator strategy and coordinating it with technology strategy and corporate strategy can reduce the technology development and commercialization time period and creates comparative advantages. In this paper we develop an itemized model to draw a bead on the activities of petroleum incubators in a patent portfolio framework and to improve the efficiency and effectiveness of petroleum incubators. The model includes several categorized items that can be taken into account stage by stage. If this model is deployed in steady stages, the petroleum incubator can ensure that every new created idea will commercialize undoubtedly. Moreover, a considerable characteristic of the proposed model is the existence of programs for the patent's application in prevailing and new created markets and also commercializing the patents of R&D activities to prevent the accumulation of unused knowledge in petroleum incubators. At the end of the paper, some suggestions to employ the model in real-life situations are recommended.

Keywords: Market research, Strategy, Technology package

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1. Introduction

The idea of incubator is usually used as a general denomination for organizations that constitute a supportive system that is conducive to development of new firms. These incubators have become a ubiquitous entity in many aspects of the world. Policy makers have come to view them as a device for enhancing economic development, innovativeness and the emergence of new technology-based growth firms (Bergek and Norrman, 2008). A petroleum incubator is a unique and greatly adaptable mixture of business Research and Development (R&D) procedures, infrastructure and human, provided to nurture

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and grow new and small petroleum businesses by reinforcing those using early stages of development and change (Figure 1).

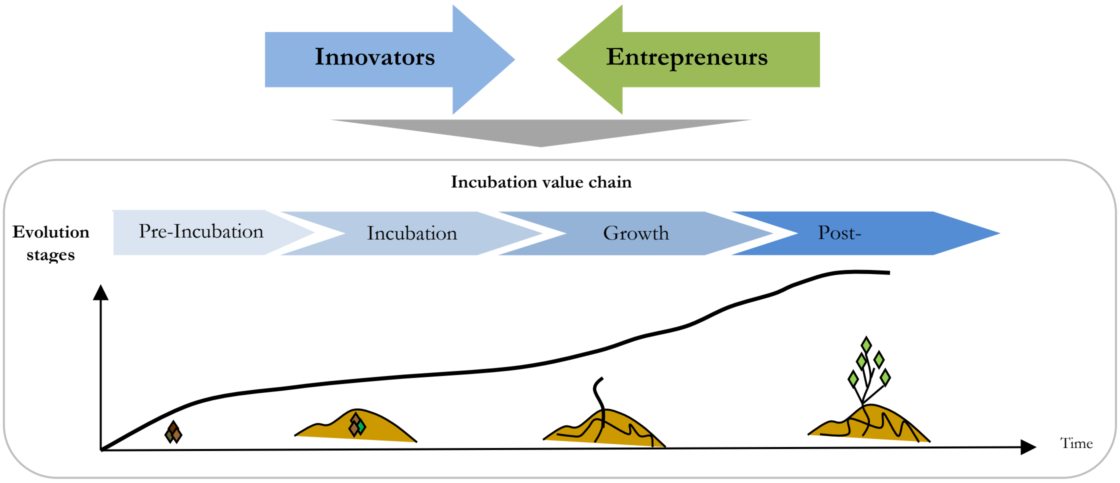

Figure 1

Incubation value chain (Authors)

Let us conduct a brief literature review herein. Rothaermel and Thursby (2005) investigated the research question of how knowledge actually flows from universities to incubators. They assessed the influence of these knowledge flows on incubator-level differential performance. Their evidence recommended that incubator' absorptive capability is a fundamental factor when transforming university knowledge into incubator-level competitive advantage. Maniyan et al. (2016) proposed a business model for virtual business incubator in Iran, based on review of the related literature, interviews with experts, and benchmarking results of various successful virtual business incubators in the world. Holgersson and Aaboen (2019) displayed a literature review of the intersection between Intellectual Property (IP) management and Technology Transfer Offices (TTOs) for the sake of finding out how TTOs handle IP. The results showed that previous studies of IP management in TTOs tend to adopt a simplistic perspective of IP management, recommending that all considerable inventions should be patented. Additionally, academic investigation into TTOs and actual TTO practices both appeared to concentrate on enhancing efficiency and yields measured in terms of numbers of patents, licenses and spin-offs.

Matour and Ameri (2021) discussed the interplay between IP rights and competition law in the context of technology transfer in the Iranian oil industry is a point this work discusses. Pattanasak et al. (2022) conducted a literature review related to key performance indicators of business incubators. They reviewed 74 studies published between 2005 and 2020. They identified six categories for performance measures. De-Esteban-Escobar et al. (2022) sought the answer of this question: whether business incubators as facilitating institutions of entrepreneurship have been determinants for the survival of startups. Their study was carried out using a statistical method of evaluation based on the application of Structural Equations Modeling (SEM) on a theoretical framework built and validated empirically in a representative sample of entrepreneurs from the community of Madrid in Spain. Chang and Cheng (2022) used a probabilistic model to empirically describe the relation between entrepreneurial mentoring or financial support and incubator patent licensing. In addition, they performed a statistical test to discover whether province-level incubator enforces policies strengthen the effect of entrepreneurial mentoring and financial support on incubator patent licensing. Pandey et al. (2022) examined international technology transfer in the health, agriculture, and climate and energy areas and incubators (including oil and gas). They suggested that innovation cooperation is a better framing than technology transfer for advancing international activities on technology for sustainable development. Baghdadi et al. (2022) identified and prioritized commercialization components in Iran's gas and oil industry to transfer technology to other industries and organizations.

At the end, it should be noted that reviewing the related state-of-the-art depicted that the matter of the current paper has not been studied. As a matter of fact, the research problem concerns the absence of a comprehensive model for assessing patent portfolio & commercialization in petroleum incubators in our country. Therewith, the current paper offers a novel stage-by-stage itemized platform for evaluation of patent portfolio & commercialization in petroleum (oil, gas or petrochemical) incubators.

The structure of the paper is as follows: Section 2 describes the research methodology. Section 3 offers fundamental concepts which are employed to build the procedure of the proposed methodology. In section 4, the proposed methodology is discussed. This section contains the explanation of 13 stages of the proposed model. Section 5 is to answer this question: How can an analyst employ the proposed model in a real-world situation? In section 6, a Delphi analysis is performed as a validation of the proposed methodology. Finally, some conclusions and recommendations are provided in the last section.

2. Research methodology

The proposed model is on the basis of (1) knowledge and experiences of the authors, (2) the existent models in the related literature, and (3) the corrective comments of Subject Matter Experts (SME). To perform the research, the following steps are taken:

1 - A complete study on the literature of patent portfolio, commercialization, incubators, technology transfer, etc., is carried out. This study includes the recognition of requirements of Iran's petroleum industry with regard to technology development. Findings of this step are discussed in section 3.

2 –The stages and items of the proposed method are drawn up (the readerships will see that the proposed model consists of several "stages" and several items"). After that, a Delphi process is performed in order to refine and to finalize the stages and the items. At the end, the framework of the model is formed. To these, a panel of 10 related SMEs is organized. The SMEs sufficiently realize the matters of patent portfolio & commercialization in petroleum incubators, and their knowledge/skills are acceptable to take appropriate judgments. Findings of this step are shown in section 4.

3 – Various ways to apply the proposed model in real-world cases of petroleum industry are designed. Findings of this step are discussed in section 5.

4 – Model validation is conducted using another Delphi process and another experts. Findings of this step are explained in section 6.

3. Preliminary concepts

This section is to define, discuss, and review the key concepts employed in the proposed model. As a matter of fact, the following titles are used to establish the procedure of the proposed model.

3.1. Incubator goal

Any kind of petroleum incubator requires goals for future activity and planning. It is vital to develop goals integrated with environments and global market. These goals should come with a time frame and measurability criteria. These goals have to overcome the competition problems as well (Ricupero, 2003). All kind of petroleum incubators have their own goals. But generally, the main purpose of R&D oriented entities is doing pure basic or applied R&D. But they also may focus on technology commercialization (Teece, 2018).

3.2. Incubator strategy

Petroleum incubator strategy follows general definitions around the term organizational strategy. For example, an incubator may define its strategy as the determination of the fundamental long term goals related to petroleum industry, the adoption of the courses of action, and the allocation of resources necessary for carrying out the goals. As another instance, an incubator may set up this strategy: a multipurpose and integrated program built to assume that the basic goals of the petroleum industry are achieved.

3.3. Technology foresight

Technology foresight concerns with the most upstream components of the technology development process. Technology foresight makes inputs for the formulation of technology policies and strategies that help to development of the technological platforms. Moreover, technology foresight creates support for innovation, and incentives and assistance to enterprises in the domain of technology management and technology transfer, leading to promoted competitiveness and growth. Technology foresight has been known as a powerful tool for establishing common perspectives on future development strategies among policy making bodies (UNIDO, 2020).

3.4. Market research

Marketing is not in the center of attention in the most R&D center, but it is very vital for technology commercialization. The most important part of technology diffusion in the cluster is to verify the future market of the cluster products. The aim of marketing in the technology creation part of cluster is to assess the business potential of the technology and its product. One of the most useable tools for marketing is market R&D which complies data gathering, analysis and decision making. Today, business marketing of technology and product is a part of the economic activity (Kotler, 2000). There is a dynamic relationship among innovation and marketing. By other mean, the consequences in the technology will lead to launching new product into a market and bring up new opportunities for industrial development. Notably, the new technology should be market driven because whatever the technology outcome is must be preferred by the market (Jobber, 2002). In some situation the industry forces the companies to renew their technology and in some other situation the science enhancement pushes the enterprises to do some research and technology renewal. These renewals usually bring new market opportunities. Figure 2 indicates the relationship among those forces and the innovation enhancement. Therefore, for any technology upgrading, market R&D is a necessary activity in the process (Khaill, 2000).

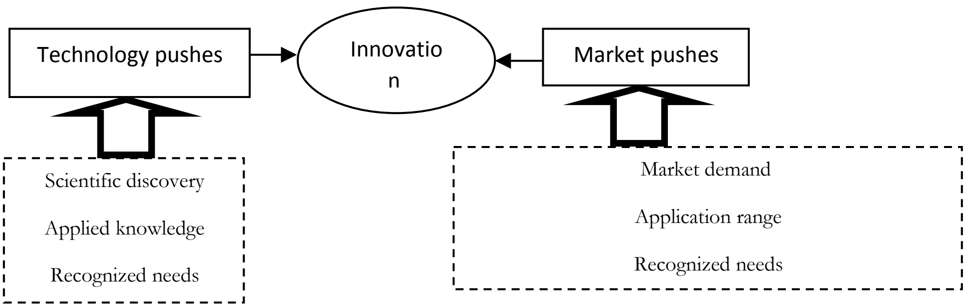

Figure 2

Relationship of environment forces and innovation (Jobber, 2002)

3.5. IP strategy and IP portfolio management

There are some studies related to IP and technology transfer (Matour and Ameri, 2021). In this regard, different researches have demonstrated that there is a positive correlation between the success of firm and the power of its patent portfolio. An IP strategy has to therefore aim to develop a high-level patent portfolio. A patent portfolio is a mixture of patents owned by a single entity, such as an individuals or corporations. The monetary yields of a patent portfolio consist of a market monopoly position for the portfolio holder and benefit from licensing IP. Nonmonetary findings contain strategic superiorities like first-mover advantages and defense against rival portfolio holders. Patent applications often lead to revenue growth in 2 to 3 years. IP has reached a higher importance in several successful firms identified as powerful ways for innovation and technology management to overcome discontinuities. Table 1 presents some definitions related to IP portfolio management tasks (Burdon, 2007).

Table 1
IP portfolio management tasks definitions (Burdon, 2007)

IP task	Definition, scope, and complexity
Scanning technology	Monitoring the patent and non-patent literature to measure current technology situation.
Current awareness/IP surveillance	Surveying newly existent patent applications and reinforcing patent intelligence/competitive intelligence initiatives.
Licensing/business development IP support	IP portfolio maintenance, patent-prosecution assistance, updating patent status information, generating reports on IP status.
Patent development/patentability	Searching and analyzing to determine identical or similar technologies.
Patent landscape	Evaluation of IP in specific fields of technology. Integration of IP evaluation data into defined format such as a landscape enabling both high-level overviews and detailed evaluation.
Infringement	Evaluation to determine if one or more patents may be infringed by a new product release to market.
Validity of patent	A search and analysis for a prior-art reference that may render a target patent or patents invalid.

3.6. Technology roadmap

Roadmaps can take a variety of frameworks, but the most common way is encapsulated in the general form of Figure 3, representing how technology can be aligned to developments of products and services, business strategy, and market opportunities. Thus, a general roadmap is a time-based diagram, containing a number of levels that include both commercial and technological views. It enables the analysis of markets, products and technologies to be discovered, together with the connections between the different views. Roadmap is a very simple graphical tool for mapping the future plan of the organization. The three most effective usage of roadmap are: (1) planning process improvement, (2) efficient R&D management, and (3) new product or services development. On the other hand, decision making by the help of roadmap is in the middle of technology pushes and market drives. In the technology push part, a group of technology enhancement projects will be reviewed in order to figure out the future of technologies. In the market driven part, based on customer needs the technologies are chosen to be invested on by a specific time frame (Khaill, 2000).

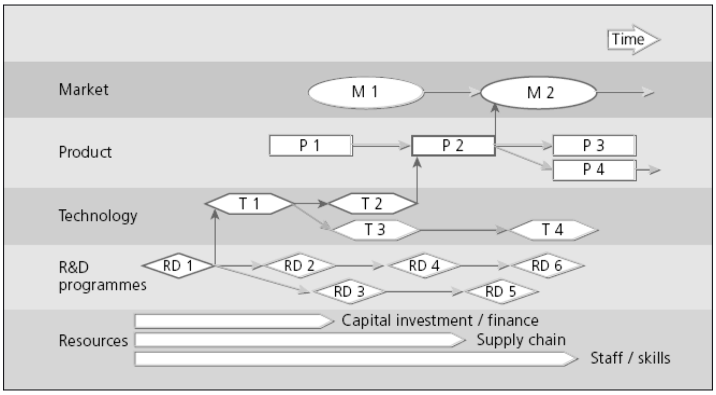

Figure 3

Schematic technology roadmap (Khaill, 2000)

3.7. Technology evaluation

Enterprises usually assess their product technology or their potential technology that they have on hand (Braun, 1988). This evaluation includes two different types: (A) Technology attractiveness assessment, and (B) Technology capabilities assessment (Arasti, 2004). Attractiveness of technology for an organization is where the technology can bring or create a new competitive advantage for enterprise. This criterion usually depends on the uncontrollable factors. In the capabilities assessment, the technological gap and its strengths and weakness are evaluated. The aim is to justify the position of the firm related to its competitor, market leader or the specific criteria defined by the experts (Panda and Ramanathan, 1996). It is vital after the recognition of weakness of the firm's technology; the related solution should be defined. Two major problems faced with organization in term of technology are as follow (Braun, 1988): 1- Lack of financial resources for technology development, and 2- Lack of knowledge related to technology.

3.8. Technical and economic evaluation

A feasibility study is defined as a process for identifying challenges and opportunities, specifying goals, explaining cases, introducing successful yields and evaluating the extent of costs and benefits related to various options for resolving an issue. This study is employed to reinforce decision making activities on the basis of a cost-benefit analysis of actual business. Feasibility study is performed during the deliberation stage of the business development procedure prior to commencement of a formal business program. It is an analytical method that consists of recommendations and constraints, which are used to help the decision makers. Technology should be reviewed from two different aspects, technical and economic. In the technical part, the analyst checks if required infrastructures, place, scale, and process are available. In the economic part, a cost-benefit analysis is accomplished.

3.9. Technology development

The aim of a technology development plan is simply to deploy a qualified, high performance, and economic technology that meets the market’s demands. The similar derivers that are driving shrinking product procedures also drive shrinking technology development procedures. The most substantial element is technology development in the production line of the system. Thus, the commercialization division of a technology is to find a group of companies related to a technology and negotiate with them for the sake of implementation of the technology in their structures. This is a very complex task and needs accurate information. The next task is to define the technology in term of system, process, products and business procedure of the technology usage (Ravi et al., 2003).

3.10. Technology localization

Technology localization consists of R&D required to reinforce the absorptive capabilities of the system. Technology localization stresses on the development of local technical human resources and policy structures to enhance the importation of beneficial foreign technologies and the creation of spin-off technologies in the system.

3.11. Technology transfer

In addition to the use of technology in the production of products, technology commercialization to transfer technology to other organizations is considered a practical approach to gain business benefits (Baghdadi et al., 2022). Technology transfer is more than just the moving of high-tech instruments from the developed world. It encompasses far than instruments, tools and other hard technologies, for it also contains total systems and their components, including know-how, products, services, equipment, and all the organizational and managerial instructions (Majidpour, 2017).

3.12. Technology commercialization

Technology commercialization is the activities of transforming new technologies into commercially successful products and services. The technology commercialization consists of trials such as market evaluation, designing and engineering, management of IP rights, marketing strategy establishment, and training. Typically, technology commercialization is a costly and time-consuming process with very uncertain conditions.

4. The proposed model

The objective of this section is to propose a model of patent portfolio and commercialization in R&D centers. The model is performed through taking 13 stages (the boxes exhibited in the figure), thus it is a sequential stage-by-stage procedure. In addition, each stage consists of several "items" to be taken into account, thus we can say that we deal with an itemized model. The items are those criteria, requirements, or tasks that should be paid attention or carried out by the analyst. In what follows, the stages are described one by one.

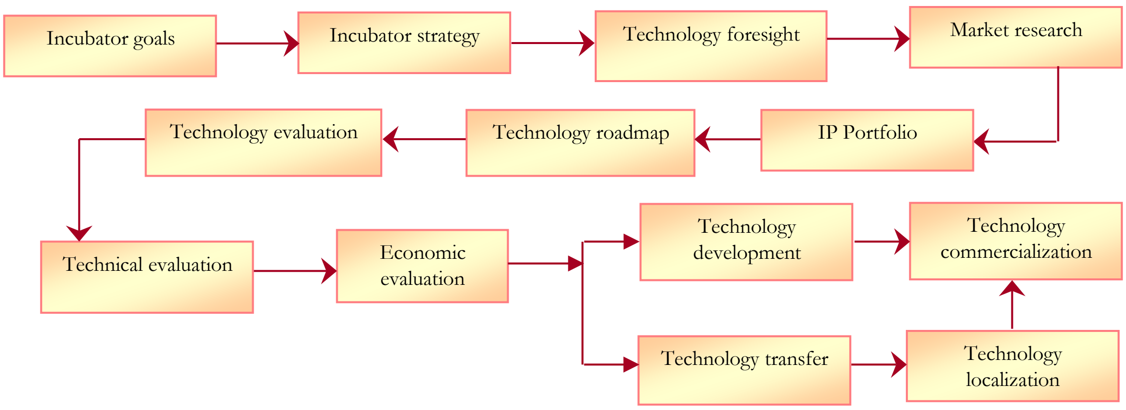

Figure 4

The proposed procedure from setting incubator goals to technology commercialization (Authors)

4.1. First stage

Main goals of incubator with considering the following items should be recognized:

- Are there enough goal statements of meaningful outputs?

- Are goals obviously stated?
- Are goals achievable?
- Is there an approximate platform to make a model for writing statements of goals? and
- Is there a flexibility to vary the goals in a given plan?

4.2. Second stage

Definition of the incubator strategy has to be specified with considering the following items:

- Levels of strategy,
- Corporate strategy,
- Strategic business unit,
- Strategic Business Area (SBA),
- Functional strategy,
- Competitive strategy,
- Strategic management procedure,
- Environmental monitoring,
- Strategy setting down,
- Missions,
- Objectives,
- Types of strategies (Corporate, Business, Functional),
- Policy,
- Strategic choice,
- Strategy implementation, and
- Strategy evaluation and control.

4.3. Third stage

Base on the future changes and customer requirements, the technology foresight with the following items is assessed:

- Systematic long-term view,
- Identifying generic methodologies/technologies,
- Economic and social yields,
- Providing the adequate compliance of investigation objectives,
- Accessing the reasonable reliability of the expert's evaluations,
- Giving experts an opportunity to understand their knowledge,
- Do not neglecting any individual expert's assessments,
- Making conditions for understanding the combined abilities of experts, and
- Structural concentration for promotion tendencies.

4.4. Fourth stage

Market R&D is accomplished for the sake of defining the market penetration of the technology, with taking the following items to account:

- Market structure evaluation,
- Explaining market environment,
- Recognizing economic and industry path,
- Measuring the size of market,
- Recognizing market segments,
- Assessing market segment size, growth score, and competitive environment,
- Evaluating business powers for market share, competitive position, etc.,
- Recognizing competitor situation and positioning,

- Constructing customer needs for product,
- Recognizing potential market challenges,
- Recognizing market distribution channels, and
- Recognizing product pricing attributes.

4.5. Fifth stage

Decision to create an IP portfolio base on the following items should be made:

- No of patents,
- What patents do we analyst have in our portfolio?
- Technologies,
- Strengths/weaknesses,
- Where should the company license in technology to compensate for areas of weakness?
- Additional uses,
- Competitors,
- Competitors' strengths,
- How many patents competitors have in their portfolios?
- Build on strengths or core competences?
- Licensing-in factors,
- R&D factors,
- Licensing-out factors,
- Donation options,
- Lapse maintenance, and
- Whether these pose a threat?

4.6. Sixth stage

In this stage we provide all the information needed for the roadmap design, as the following items:

- Reinforcing the start-up of firm's specific procedures,
- Building key connections between technology resources and business drivers,
- Recognizing major gaps in market, product and technology intelligence,
- Designing a first-cut technology roadmap,
- Reinforcing technology strategy and planning initiatives in company,
- Reinforcing relationships between technical and non-technical roles,

4.7. Seventh stage

In this stage, the technology is selected on the basis of different items as follows:

- Complete activities to identify relevant existent technologies,
- Technical study on different technologies,
- Economic study on different technologies,
- Financial study on different technologies,
- Political study on different technologies,
- Environmental study on different technologies,
- Safety study on different technologies,
- Risk analysis of different technologies, and
- Application of decision-making methods for selection,

4.8. Eighth and ninth stages

After the selection of technology, it should be evaluated from technical and economic items, such as:

- Goal and State of Work (SOW) of project,
- Sources of production supplies,
- Technical attributes,
- Schedules of net benefit and investment needs,
- Benefit-cost analysis,
- Financial road map,
- Assumption for implementation
- Essenes and nature of project,
- Setting of the project location,
- Supplies and competitive clients,
- Staffing requirements and sources,
- Physical, economic, and social characteristics,
- Regional, national, and international economic relevance to project,
- Governmental policies and plans,
- Explanation of the issue statement,
- Sampling and survey methods employed to support project,
- Form and quality of product or service,
- Projected overall demand in markets to be served,
- Projected competitive supplies and services,
- Sales potential and projected sales prices, and
- Marketing program and projected marketing costs.

4.9. Tenth and eleventh stages

In these stages, the engineering of the technology becomes active and is started or decided for technology transfer, with considering the following items:

- Studying of technical/technological feasibility,
- Determining the implementation needs,
- Recognizing potential safety and environmental risks,
- Carrying out an initial production evaluation,
- Approximating engineering prototype costs,
- Recognizing materials, processes, components, and production stages,
- Examining materials and procedures,
- Designing and building a pilot platform or engineering prototype,
- Performing an initial production feasibility analysis,
- Optimizing the design tasks,
- Fulfilling required final tests,
- Providing engineering documents,
- Recognizing scale up requirements, and
- Establishment of plans for scale up.

4.10. Twelfth and thirteenth stages

The technology should be localized and commercialized here. The analyst has to take the following items into account:

- Linking a technology to a job to be done,
- Recognizing competitive options to the use of the technology,
- Recognizing major market segments,
- Recognizing unique and differentiated yields,
- Articulating a value proposition for product,
- Possessing a comprehensive realization of the required value chain,
- Designing a cost model,

- Obviously articulated the product concept in adequate detail,
- Characterizing the market for product,
- Providing opportunities for growing fast enough,
- Recognizing the value chain,
- Defining a good way to obtain required relationships with value chain participants,
- Providing a comprehensive business plan,
- Submitting the business plan to potential resource,
- Characterizing the market for product,
- Building a credible plan for obtaining the participation of critical value chain members,
- Having positive feedback relating to the functionality and value of the product,
- Starting to create sales to target users at or near projected prices,
- Articulating the sales/distribution strategy, and
- Product should be ready for general release.

5. Applying the model

How can an analyst employ the proposed model to assess a real-life case of patent portfolio & commercialization in petroleum incubators? To answer this question, this section suggests four approaches as follows.

5.1. Checklist

The analyst can make 10 checklists according to the 10 sets explained in previous section. For a given set (e.g., the first stage), the checklist is a list of all the items that the analyst needs to check to do or to apply. Such checklists are management tools that list different activities and behaviors that need to be followed. When checking, each performed/applied item is assigned a tick mark; otherwise, we must answer/observe why that item has not been done.

5.2. Qualitative

In this form of application, a qualitative scale such as very low, low, medium, high, and very high are considered. Thus, for each item, a level from the scale is determined. Now, a strategy to control is used, e.g., if a given item is measures at medium or lower level, an action should be taken into account to increase the level.

5.3. Semi-quantitative

Semi-quantitative indicates assigning an ordinal numerical score such as 1, 3, 5, 7, and 9 to each item. In this case, like qualitative method, corrective actions should be taken into account when the score is under a predetermined threshold. In addition, an overall score for project can be calculated by summation of all the individual scores. This overall score can be used to compare different projects, or to measure this overall number with an overall threshold.

5.4. Quantitative

This form of the analysis is a deep method to evaluate the project. In this case, each item is dedicated a rate between 0 and 1, in a way that 1 depicts the best result/condition. After that, each item is assigned a numerical weight (between 0 and 1) indicating proportional importance of the item over the others. Finally, weighted summation of the rates is computed. This overall rate presents the level of the project success on the interval 0 to 1. Like the semi-quantitative method, the analyst may use thresholds (individual threshold for each item, and overall threshold for project) to control the project.

6. Validation of the model

A Delphi evaluation has been performed as a validation of the suggested methodology. Four scientific meetings have been held with 5 experts with adequate knowledge and experiences in the patent portfolio, commercialization, and petroleum incubators. It should be noted that these experts completely differed from the SMEs who participated to establish the model. Each expert lasted about 3 hours. After completely explaining the model and its components, the experts rated the model with a score from 0 to 10. In addition, they took its potential effectiveness and flexibility into account. The mean and the standard deviation of the scores were 8.25 and 1.12. Further, the experts expressed the reasons for their judgments. The major notes expressed by the experts were (1) rather comprehensive, (2) well-structured and easily applicable, (3) easily customized to implement in various situations and (5), anyway the model needs many professional meetings.

7. Conclusion

Development of technology and IP management require to be intertwined to make sure success and viability. The high complexity of technology R&D, the need to develop global market strategies, reduction of product life cycles, and broadening product portfolios require an integration of IP management procedures and product development. Petroleum incubators can capitalize on the integrated IP management approach by combining state-of-the-art IP search and analysis tools and techniques.

In this paper the related literature was reviewed. Base on the literature review, we observed that there is no comprehensive and well-defined model in this area. Thus the paper offered a stage-by-stage itemized model for analysis of patent portfolio & commercialization in oil, gas or petrochemical incubators of Iran. This model introduced the most efficient and effective way of developing the technology, by using several "items" categorized in different aspects, including incubator goals, incubator strategies, technology foresights, market research, IP strategy and IP portfolio management, technology roadmap, technology evaluation, technical and economic evaluation, technology development, technology localization, technology transfer, and technology commercialization. In addition, four methods to employ the items in real-life situations were suggested.

Future researches can be undertaken to work on the development of the suggested methods to employ the methodology in real-life situations. This recommendation refers to develop comprehensive and more applicable techniques in this area, for example to incorporate criteria weighting methods to estimate the weight of each item.

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