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METHODOLOGY FOR THE CONSTRUCTION OF TECHNOLOGY-BASED PRODUCT IDEAS FOR EMERGING MARKETS

THESIS

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DEDICATORIA

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SUMMARY

As developing and emerging regions of the world are experiencing accelerated growth in populations and income, they are becoming more important to define the future of many industries, this is why developing and emerging countries and the markets they represent, constitutes enormous opportunities for companies and entrepreneurs willing to take advantage of their technology hunger, by developing technology-based products for the satisfaction of their particular needs and expectations.

This document presents a Methodology for the creation of technology-based product ideas for emerging and developing markets. The methodology leans on the analysis of technology trends for the exploitation of entrepreneurs’ technical capabilities, and the identification and analysis of the characteristics and needs of a specific market, with the main objective of aligning the technological development to particular less-developed markets.

The methodology is supported by creativity tools, information analysis practices, technology commercialization processes, and methods for evaluation and selection of products before their introduction to the market.

Each step of the methodology presents a succession of activities to be made, inputs required and key results. Some suggestions gathered from the literature are also included in each step in order to facilitate the understanding of developing and emerging markets particularities.

In order to demonstrate the methodology presented in this document, and also as an important source of experiences for the author, a case study was carried out in the Low-Income Mexican Agricultural Market. All the information contained in this case study has been used for the design of a low-cost customizable greenhouse for the Mexican Ejido.
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CHAPTER 1. INTRODUCTION

1.1. Research context

Growing competition in developed countries has forced many entrepreneurs to seek new options. As some developing countries have been growing and gaining competitive positions in the global environment to the extent of being considered emerging economies, the chances for entrepreneurs to do business in these nations of opportunities increases as well.

Moreover, as those emerging economies (and emerging markets as will be explained later) are also entering the vast competition in the global economy, technological change and innovation are becoming their motors in order to make their expansion not only possible but also sustainable. Technology has been introduced not only in the industry, but also in the day to day life of people who have easily adopted enormous quantities of technological devices.

Nevertheless, the evolution and growth of emerging countries has not been achieved in a balanced way, whereas only some population groups have been able to follow the steps of these products and services designed for people and companies in developed countries. It is because of this that some sectors of the population have not taken proper advantage of technological developments or which is the same, entrepreneurs have not taken proper advantage of those particular markets that would represent important prospects for becoming clients of technology-based products that could suit their needs: “Technology doesn’t change anything until people with vision and determination do something with it” (McCormick, 2006).

Therefore, the challenge is to develop technology-based products and services according to market needs and characteristics. Serving emerging and developing economies requires many changes regarding common price envelopes, consumer education, and innovations in process and products. These markets are offering
opportunities for product development based on what for them would be "emerging technologies," which could translate into radical novelty and evolution.

A second challenge consists on the need of rapid and effective methodology for the ideation, design, manufacture and commercialization of new products with high quality, low cost and in a timely manner for those markets.

In the Tecnológico de Monterrey, it has been developed a complete reference framework and a methodology for Integrated Product, Process and Manufacturing System development (Molina, et al, 2007). This methodology incorporates models, methodologies, techniques and best practices and technologies for the rapid product realization. By using this framework, it can be reduced the time from a product ideation to its production.

But this could not be enough, because this challenge goes further. The product development process has been studied and enhanced within the time, it has been recognized the importance of the product design phase due to the amount of money that the entrepreneur and designers can save if they make a robust design and the facility to make substantial changes in this stage, without representing a big change in the budget. The assumption of a successful idea of product is the initial point for this phase where stakeholders will expend money and resources on understanding the potential market or customer and the environment in order to achieve the design of a good or service that attains the expectations of the client.

But, the way an entrepreneur comes to an idea of a product that could be successful in a specific market has not been considered in traditional product design or product development methodologies or reference frameworks. This is why this thesis is focused on providing entrepreneurs (be it a experimented group of professionals or a just graduated engineer) with a series of steps that can be developed in order to achieve the creation of a technology-based product idea for a specific emerging market, that will increase the chances for its successful commercialization.

A first attempt by the research chair “Rapid Product Realization for Developing Markets using Emerging Technologies” for a methodology that supports the alignment of
technology and markets in the conceptualization of products, was presented by Valerio et. al (2008a) and Valerio et. al (2008b). In that proposal, the general process of market’s needs coverage identification using emerging technologies was applied for the conceptualization of a Low-Income Green House.

The main result of this thesis research consist on a methodology that attains the creation of a product idea since the screening of the technological progress and the monitoring of market environment to the generation of some product idea and their evaluation according to their commercializability potential. Information handling is one of the cornerstones of this methodology: primary and secondary information sources are proposed where needed, and techniques for analysis of the information collected are also presented. For the evaluation and prioritization of the commercialization potential of the product ideas, a variant of the Analytical Hierarchy Process (Saaty, 1990) is proposed.

NOTE: The term “developing/emerging market” and “developing/emerging economy/country” in this research will be used to interchangeably. Since the focus of this research is on those less developed regions, which suggest “developing ore emerging markets” for some technological products and services.

“Emerging Technologies” are understood in this document as all those technological advances that have not been introduced or accepted by those “emerging” and “developing markets” studied in this thesis.

1.2. Research work challenges

The challenge presented in this research emerges from the previous explained situation. The key question to be answered by this research is:

Which methodology of creation of product ideas provides an efficient path to align real emerging markets’ necessities with available technology?
Chapter 1. Introduction

In order to appreciate the functional relationship of the subjects of the research problem, the identification of the variables is meaningful:

**Independent Variable**: Product Ideation methodology.

**Dependent Variable**: Efficient merge between emerging markets’ necessities with available technology.

Thus, the aim of the methodology will be directed to the construction of product ideas, and their prioritization in order to assure the usability, adjustment and acceptance of a technology-based product ideation in a selected emerging market. This aim will be reached by structuring a helpful methodology to identify emerging economies’ needs and expectations, identifying which technologies can satisfy those needs and selecting some products/services ideas.

1.3. Objectives

The general purpose of this investigation is the development of a methodology for the ideation of technology-based products or services, in order to provide to entrepreneurs of a business opportunity to conceive ideas that could be successful in emerging markets.

The specific objectives of this research are:

- Recognize existing techniques, tools and methodologies to construct ideas for new products, as well as identify the way technology developers get advance of their progresses to offer a benefit for the market.
- Design a methodology that allows in a structured way the ideation of technology-based products or services that could be successfully commercialized in an emerging or developing economy.
- Integrate in the methodology the consideration of the needs and characteristics of the specific market selected to facilitate the acceptance of the product.
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- Offer the entrepreneur with a tool that allows him to increase their possibilities of success in the commercialization of a technology-based product or service in a developing or emergent market.
- Support like input to product designers’ works directed to emergent and developing markets.
- Underpin designers to obtain a robust design of the product in a specific context.
- Demonstrate the proposed methodology by carrying out a case study.

1.4. Expected Results

At the end of the research, the expected results are:

- Delivery of clear steps for technology-based idea generation, evaluation and selection.
- Generation of a methodology that compiles a set of techniques and best practices for the collection and analysis of market and technology information for the generation and prioritization of product ideas.
- Demonstration of the methodology in a case study.

1.5. Research Questions

With the meaning of orienting the development of the literature review, the investigation questions are established:

1. What are Developing and Emerging Markets?
2. Which characteristics do emerging markets’ share?
3. For entrepreneurs, which are the advantages and constrains that kind of markets presents?
4. What is an Emerging Technology?
5. Which challenges are related with technology commercialization?
6. Which is the importance of product ideation in the product realization process?
7. How the product ideation is made? What methodologies or techniques are applied for that purpose?
8. How technology-based products are ideated?
9. How do entrepreneurs assure the success of technology-based products in the market?
10. Which methodologies exist for assuring success of technology-based products commercialization?

These questions are going to be answered along the literature review presented in the next chapter.

1.6. Justification of the Research

Nowadays environment in developing and emerging economies forces enterprises and entrepreneurs to constantly innovate the products and services they offer. The literature presents numerous methodologies for product development; nevertheless, they regularly do not analyze the process by means of which the conception of the product idea is done. It is usually said that is big part of “heart” and “feeling” finding of good ideas for product development.

The generation of ideas for products in specific markets is usually resulted of the environment observation in which the developer or entrepreneur is immersed. In cases where the enterprise or entrepreneur has identified a technological expertise in determined field, they employ some techniques to stimulate the innovation between groups. Those brainstormings usually go around the initial statement of encountering an application for the technology developed by the firm (or entrepreneur), and under the assumption that the development level or novelty of the technology being developed will assure it acceptance and thus, its commercialization success.

Nevertheless, the success of a technology-based product in the market is not assured by the technology development and the innovation on it. Many researchers are developing laboratory trials and they are getting more and more impressive
technological developments, without having a clear idea of any feasible application of that technology in the outside world.

It is a fact that as technology gets more advanced, the products that are being used for its demonstration are usually targeted for commercialization in developed markets. For instance, new manufacturing technologies could hardly be acquired by small or medium size enterprises on emerging or developing markets, they usually can not afford state of the art technologies, instead of that, they could be able to pay for established technologies with a new approach thought for their special requirements and in such an innovative way that could represent a giant step forward for them in terms of competitiveness.

Traditionally, two kinds of approaches have been used to innovate and to introduce technology into markets: technology-push and market-pull. The former has been used mainly by technology developers or scientists that seek for an application to demonstrate the novelty and usability of their technology. The latter comes as a result of an articulated demand of the market, but not always this is solved by means of high level technology.

Many enterprises based on a first product idea, spend months on a design and prototyping of their new product. And just then spend their marketing resources for digging out market research reports in order to have an idea of the market potential of their invention.

A new approach must be taken for developing technology-based products for emerging markets. There is a need for a methodology that allows the identification of a particular market, to cover their necessities by means of a characterization of the customer and the analysis of the potential technological solution of its necessities to cover them with “new technologies”. It is not just about doing traditional market research surveys or focus groups, because in this case, it is about totally-customized products for a emerging or developing market. It has to do with understanding of their features, restrictions, opportunities, habits, customs, etc.
Chapter 1. Introduction

The main motivation of this thesis research is to provide entrepreneurs and enterprises of a step by step methodology for creation of technology-based product ideas that could represent for them business opportunities in less developed markets.

1.7. Scope of the Research

This thesis presents the results of a research work carried out by the author since August, 2007 in the frame of the research chair “Rapid Product Realization for Developing Markets using Emerging Technologies”. The main product of this research was the creation of a methodology for aligning technological products development to emerging and developing markets’ needs.

The methodology presented in this document provides entrepreneurs and technology developers of a first template to conceptualize products based on new-to-developing/emerging-markets’ technologies that could have an important potential of market penetration and customer interest. The methodology comprises the first phase of the product realization process which is related with the product ideation until its evaluation and selection for further product design.

The methodology presented in this research work is supported by the experimental knowledge developed in the research chair quoted, but also with a strong focus on the state of the art literature review on Product Conceptualization and Technology Commercialization.

1.8. Structure of the Thesis

The thesis is structured in the following manner:

- Chapter 1: Introduction to the research context and challenge, including the objectives, expected results and justification of the research.
- Chapter 2: Research methodology, presenting the process for achieving the thesis objectives.
Chapter 1. Introduction

- Chapter 3: Literature review explaining the main concepts that are required to understand the methodology proposed.
- Chapter 4: Methodology, describing in a detailed way the new methodology and each one of its stages and activities.
- Chapter 5: Case Study presenting the application of the methodology to the low-income Mexican agricultural market. This case study was carried out by the research chair “Rapid Product Realization for Developing Markets using Emerging Technologies”.
- Results, Conclusions and Future Work: Each one of the objectives achievement is discussed, and in function to those results some conclusions and recommendation of future work and future research lines are made.
- Annex 1: The methodology is recapitulated in tables that include the main inputs, activities, outputs, tools, resources and comments for each process.
- Annex 2: Complementary information to the case study.
CHAPTER 2. RESEARCH METHODOLOGY

2.1. Introduction

In this chapter the author describes the research methodology to be followed during this thesis elaboration. The hypotheses are going to be structured and the author will propose the way in which the validation of the proposed model will be carried out.

2.2. Hypothesis

The adjustment of technology commercialization models to the characteristics of new-to-emerging-markets technologies and emerging markets can result in a methodology to conceptualize successful and feasible technology-based products for less developed regions.

The utilization of a methodology to create ideas of technology-based products based upon a specific market increases the possibility of commercialization success of the product. The utilization of such methodology diminishes the resources spent on designing and developing products that will not satisfy potential customers' necessities.

Variables:

- **Methodology to ideate technological-based products based on a specific emerging market necessities and characteristics:** It refers to the methodology to be proposed which will integrate both, the monitoring of emerging technologies and a specific emerging market.

- **Adjustment of technology commercialization models to the characteristics of emerging technologies:** It refers to the adoption of technology commercialization models, principles and techniques to the particular features of emerging markets by one side, and to emerging technologies by the other.
Chapter 2. Research Methodology

- **Resources spent on designing and developing products:** It refers to all the resources such as money and human time invested on the design and developing a product.

2.3. Research pathways

The research to be presented on this document will be developed in the context of the research chair “Rapid Product Realization for Emerging Markets using Emerging Technologies”. The methodology and reference model provided in this document emerges from the necessity of a series of steps that assures the adequacy of a technological-product idea to a particular market for its successful commercialization and market adoption. Subsequent chapters will present a conceptual solution that will consist on the methodology itself (Chapter 4), and finally a study case will be presented in order to validate the methodology in a real environment (Chapter 5).

The research methodology includes three different pathways referring to the 3 different sources of information and analysis that will help develop the project and that will converge in a point in which both of them contribute in the work proposed (See Figure 1).

1. Literature Review of the two focuses of the methodology: Review of the literature that provides insightful information about the features, categorization, and concepts of Emerging Technologies and Emerging Markets.

2. Literature Review of Conceptualization of Technological Products: This consists on the appraisal of some methodologies and best practices for Product Ideation (or conceptualization) as well as Technology commercialization methods and its capability to be used for our research context. A review of the immersion of technology-based products will be done in order to identify the success factors to be considered in this work.
3. Experiences from study cases: Some projects are being developed by the research chair team at Tecnológico de Monterrey that will be used as demonstrators of all the concepts presented in this research. The conceptual development of the methodology will be carried at the same time while two projects are being developed. In Chapter 3 one of those study cases will be presented.

These information sources complement each other, and the information obtained from them, will converge on a novel solution for the problem presented in Chapter 1.

2.4. Overall Research Steps

In this section the author presents the research steps to be followed in the consecution of the objectives of this thesis. An overall perspective will be presented including the integration of all the steps and those that deserve more attention will be explained in a more detailed way.

In order to develop the research proposed before, and in order to achieve the objectives stated in the first chapter, the author will follow a research methodology that is consistent
with the work plan stated for the research chair mentioned above. In Figure 2 is presented the working plan of the research chair, work packages and deliverables of each one of them are depicted. Discontinuous lines are used to identify those working packages that were not used for the development of this thesis.

**Figure 2. Consistency between the research chair’s work plan and this research**

- WP1: Preparation of detailed working plans.
- WP2: State of the art review on Emerging Technologies.
- WP3: State of the art review on Emerging Markets.
- WP4: Methodology generation.
- WP5: Application of methodologies (using Action Research) to study cases.
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- WP6: Methodology improvements (using Action Research)
- WP7: Project Management

For the purpose of this research, WP2 and WP3 leveraged the knowledge to support the identification of the objectives and distinctive of the methodology that the author is looking for.

As part of the research developed in WP4, the review of product design processes (including the stage of product conceptualization) was reviewed.

WP5 and WP6 allowed the enhancing of the methodology by means of its execution, observation of its effectiveness and hence, the enhancement of the methodology.

The study case and the enhancement of the methodology followed an Action Research approach, AR is defined as a spiral process that allows action (change, improvement) and research (understanding and knowledge) to be achieved at the same time (Barskervillea and Pries-Hejeb, 1999). The methodology Action Research includes four stages: Plan, Act, Observe and Reflect that, in our case, will support the execution of the case study for a product conceptualization in WP5 and the robustness of the methodology in WP6.

2.4.1. Work flow perspective

In Figure 3 the representation of the steps followed for the overall research process is presented. Note that the Conceptual Definition, Methodology Development and the Case Study Presentation are highlighted to depict that they constitutes the main contribution of this research. The steps are as follows:
1. Research Proposal: Once defined in previous step the topic of interest, the author looked up for the best way to design such methodology. It could happen only after a complete understanding of the characteristics and particularities of the Emerging Markets and the Emerging Technologies, as well as the newer trends for the commercialization of technology-based products. A tentative topic was narrowed in order to create a particular methodology for the conceptualization of technology-based products to cover necessities of emerging markets, particularly in México.
2. Hypothesis Statement: After a first approach to the problem, the author attained the conclusion that the selected topic was worthy to be investigated, and it was also identified the Jolly’s model as a strong starting point to develop a methodology to accomplish the objectives of this thesis.

3. Literature Review: The main concepts surrounding the research topic selected are studied and understood in Chapter 3. The main objective of the literature review is to answer the research questions formulated in Chapter 1. The definition of Emerging Markets, their characteristics and challenges are presented and the depiction of México as one of those Emerging Markets is also done. Emerging Technologies definition, their characteristics, and the existing challenges for its commercialization is also introduced. The Product Development phases are investigated to identify the importance of a good Product Conceptualization, and some best practices employed for product conceptualization are listed. Finally, the literature review allowed the author to familiarize with the Jolly’s model for Technology Commercialization.

The knowledge and understanding generated in the literature review, allowed the enhancement of the research proposal.

4. Conceptual Definition of the Methodology (Generalities of the Methodology): A definition of the methodology is presented in the first sections of chapter 4, where the main bases of the methodology are referred to. In order to include all the significant aspects to the design of the methodology and trying to take into account all the restrictions and challenges presented by the two main elements that constitutes the focus of this research (Emerging Markets and Emerging Technologies), the models and techniques presented in the literature review are analyzed in Chapter 4, and the characteristics of them are also contrasted with the necessities of the two elements mentioned.

5. Methodology Development: In this part the author proposes the methodology for conceptualizing technology-based products for emerging
markets. It is presented a depiction of the methodology steps in a global way and each of its elements is explained. For the completion of this methodology some supporting techniques are proposed and explained.

6. Case Study Presentation: This research was developed in a parallel way with the development of one case study. This case study nourished the methodology by providing it with empirical experience, and it also allowed the author to validate it in a real scenario.

7. Conclusions: This methodology integrates a very important and validated model (from Jolly) to the particularities of Emerging Technologies for Emerging Markets, thus naturally it gives plenty of conclusions and insightful comments to be taken into account.

8. Future Research: This research has a limited time frame; nevertheless it intends to be a cornerstone for the establishment of the methodology to be used for further product developments of the research chair that supported this work, so that the author defines further steps in the areas of research, validation and improvement of the methodology.
CHAPTER 3. LITERATURE REVIEW

3.1. Introduction

The theoretical foundations shown in this chapter will serve as a conceptual basis for the development of a methodology that allows the ideation of technology-based products focused on the satisfaction of necessities of specific emerging markets, in a systematic and structured way. The market focus of those technology-based products will be attained by identifying and analyzing the particular opportunities, trends and constraints of product commercializing at emerging and developing markets. Further, the methodology presented will be based on emerging technologies.

This literature review provides an introduction to the generalities of Emerging and Developing Markets and Emerging Technologies, as the center of attention of the methodology presented. The second part of this chapter will consist on the revision of product development literature, in order to identify processes employed to conceptualize or ideate products. This chapter will be structured as is shown in the Figure 4.

![Figure 4. Literature Review Framework](image-url)
3.2. Developing and Emerging Markets

The financial industry makes a distinction between three main categories of international markets according to their maturity and level of risk. Investors differentiate between developed markets, developing markets and emerging markets, and normally this classification is tagged to entire countries or economies.

A developing market economy is defined as an economy with low-to-middle per capita income (a GDP of less than USD $10 000), and typically are in course of industrializing. According to Prahalad, (2004), such countries constitute approximately the 86% of the global population, representing about 14% of the world’s economies. Some times the term is confused with emerging markets, but this is not correct, since emerging markets are those countries that are in the translation between developing and developed markets.

Developed markets are those mature markets that have reached a state of equilibrium that is manifested by the absence of significant growth or innovation. Developed markets include big economies such as U. S., Japan, Western Europe, Canada, New Zealand and Australia. Those markets are large in market value and in volume of trading. The urbanized infrastructure, as well as the deep-rooted financial services companies in these countries facilitates the selling-buying processes, that makes developed markets more liquid because the system is more efficient and there is acquisitive power enough to allow it.

Other advantageous characteristics of those markets are the transparency of the trading as well as the security of investing due to the political and social regulations. Nevertheless, mature markets present challenges for product/services providers, due to the huge quantity of competitors within.

Emerging markets are countries that in the last fifteen years are making a critical transition from developing markets economies (previously known as countries of the third world) to more developed markets. In contrast to developed markets, emerging markets are usually significantly smaller, some times newer and therefore, less liquid and more unstable and risky. Nevertheless some experts believe that they are enjoying
an increasing role in the world economy and on political platforms, as a result of the involvement of the private sector on their development.

According to the World Bank (2002), the five biggest emerging markets are Brazil, Russia, India, China and South Africa, this group is known as BRICS. In Figure 5 the depiction of the emerging markets, developed markets and developing markets is offered.

![Figure 5. Developed Emerging and Developing Markets in the World](From O'Neill, et al. 2005)

According to their demographic profiles, there are other countries that might have BRICs like potential: the Next Eleven (N-11), though whether they will emerge is still an open question for many. This group includes Bangladesh, Egypt, Indonesia, Iran, Korea, Mexico, Nigeria, Pakistan, Philippines, Turkey and Vietnam (O’Neill, et al. 2005). Other authors include in this description countries like Argentina, Poland and South Korea.

However it is important to notice that in emerging economies, no all the population is in such favorable conditions. Emerging countries have many faces, there are the big urbanized (and wealthy) regions for which the countries can be tagged as “emerging”, but there is also the other side of the coin where economical, social, cultural and geographical factors are not as favorable in “developing” areas within the country or...
economy. For this reason, the importance of “regionalizing” the markets in this research is high.

3.2.1. Characteristics of Developing and Emerging Markets

Besides the economical characteristics previously explained of developing and emerging markets, Rusell (1998) makes the following classification of those markets characteristics:

**Physical characteristics**

Emerging and developing markets lack of an infrastructure capable of supporting increased commercial activity. Insufficient capital is the most often problem, although in countries where funding for capital is more available, the problem consist on the lack of technical know-how necessary for the efficient implementation of the infrastructure. Inadequate infrastructure makes market entry more difficult. Physical facilities important for marketing purposes are:

- Communication: practically all emerging markets lack a communication system to support adequately commercial activities.
- Transportation: typically, air transportation is controlled by the government, roads are unsurfaced, and sometimes there is an inadequate network of road and rail transportation.
- Power Generation: many emerging and developing markets lack enough power-generation facilities to sustain a minimum level of commercial development.

**Socio-political characteristics**

Many emerging countries are more volatile politically than developed nations, as they are normally undergoing a complete transformation of their political and economical structure. Another characteristic is the reduced level of technological development.
3.2.2. Business Opportunities in Developing and Emerging Markets

Opportunities presented by emerging and developing markets can present advantages for large firms, not only by expanding their market but also due to the benefits gained from operating these markets that can also have significant influence on the management practices of the global firms. In the literature, there are many study cases of successful business developed on emerging markets, especially in India (Prahalad, 2004). Some of the practices developed by these pioneers have been copied or have been taken advantage by people in developed markets.

In the new global economy, the tendency suggests that the competitive advantage will be for those companies capable to develop products rapidly with a focus on the client. The economical success of organizations depends on their ability to identify the necessities of the market and the development of products which satisfy those necessities with a low cost and in the lowest time.

Emerging economies contain varieties of segments, all of which are moving rapidly upward. There is no a global-massive market opportunity, there are diverse segments such as the rich and super-rich, the middle class, the poor and the rural. All these segments share a common environment and characteristics, which represent challenges for companies entering to them, but also represent opportunities for companies with the right solutions for their necessities and cultural, social and political characteristics (Mahajan et Banga, 2006).

In this way, the innovation plays a central role for emergent markets; Prahalad (2004) establishes the principles to be considered in order to constitute the basis for innovation for these emerging markets: through making small packing units, low margins per unit, high volume, and high return on capital employed as well as innovative schemes of payment these markets consumption can be encouraged. A critical requirement is the ability to innovate ways that take into account the uncertainty of the cash flows of poor people that makes it difficult for them to access the traditional market for goods and services oriented toward the developed markets.
Because the developing economies force an extraordinary emphasis on price performance, firms must focus on all elements of cost. The efficiency in the capital use is a must that firms must focus on. Sustainability in packaging is another source of knowledge that developed markets can get form experiences in emerging markets, as well as the innovation that must become “value oriented” from the customer’s perspective.

Emerging markets are experiencing an accelerated growth not only in population but also in income, this combination historically translates into tremendous consumer demand for all kinds of products and services, and this is making them fertile soil for companies selling products and services. Together with the consuming power, emerging markets offer a better opportunity for rapid market expansion and less intense competitive environment. Two relevant examples are the countries with the highest populations in the world: China and India.

Furthermore, many companies from mature economies, such as U.S. companies are expanding their business operations into emerging markets (e.g. Unilever in India, Wal-Mart in Mexico, Sony in Brazil, etc.). This type of international investment can further accelerate the development and growth of the domestic economies, as experienced companies bring money and modernized business practices to emerging markets.

### 3.2.3. Mexico as an emerging market

Mexico has a free market economy, and according to the World Bank (2002) in its list of economies, Mexico is one of the less indebted countries with an upper middle income (this is between $2,976 and $9,205 USD). Mexican economy has gone through a significant transformation in the last twenty years, after the 1994 economic debacle, due to deregulation, a more open economy, reduced inflation, and strengthened public finances; as a result, vulnerability to crisis has been greatly reduced (Randal, 2006).

Recent administrations have improved the communication and transport infrastructure and have also opened competition in seaports, railroads, telecommunications, electricity generation, natural gas distribution and airports. The oil is the largest source of foreign
income, and nowadays it is being a national debate about opening the energetic sector in the country, with purpose of improving the services and infrastructure of the oil industry in Mexico by increasing the competition.

The poverty in Mexico has decreased considerably, according to the director from Mexico at the World Bank, from 24.2% in the general population in 2000 to 17.6% in 2004 (El Universal, 2005), nevertheless as in other emerging or developing markets, inequality is still a problem. It is contradictory the fact that the richest person of the world, Carlos Slim, is Mexican, while a 17.6% of Mexican people live in poverty. Huge gaps remain not only between rich and poor but also between the north and the south, and between urban and rural areas. These gaps refer not only to income, but also to human development and quality of life.

However, the poverty reduction and the increase in purchasing power of the middle class are attributed to the last two administrations. The GDP (Gross Domestic Product) annual average growth for the period of 2007 was 4.6% (CIA, 2007).

Since the middle of the 80’s, the country adopted a neoliberal economic model with an emphasis on commercial openness to other countries. Mexico’s principal commercial association is the TLCAN (Tratado de Libre Comercio de América del Norte) or NAFTA (North American Free Trade Agreement), and almost the 85% of Mexican trade goes to North America (United States and Canada). Other major trade agreements have been signed with the European Union, Japan, Israel and many countries in Latin America.

The closed trade-relation with United States represents a benefit, but also an economical concern because of the Mexican dependence on that country. For instance, in the last year the economic recession in the United States also caused a similar pattern in Mexico.

In Mexico the first source of income is the petroleum exportation, followed by the shipment of remittances from the United States, and the tourism is the third one.

Nevertheless, according to O’Neill et al. (2005), Mexico (jointly with Korea) have the highest income levels of the N-11 group by a margin of about US$7,000; and it is
estimated that for 2025, Mexico will be the eleventh biggest economy of the world, and for 2050 the sixth one, only preceded by China, US, India, Japan and Brazil (Figure 6).

![The Largest Economies for 2050](image)

*Figure 6. The Largest Economies for 2050 (O’Neil, et al. 2005)*

In terms of income per capita, the forecast is somewhat different. By 2050, Mexico converge to develop country income levels at roughly US$ 55,000, occupying the tenth place following US, Korea, Japan, France, UK, Germany, Canada, Italy and Russia (Figure 7).

![Income Per Capita: 2050](image)

*Figure 7. Income Per Capita for 2050 (O’Neil, et al. 2005)*
Concerning energy, in Mexico it is managed by state-owned companies, CFE (Comisión Federal de Electricidad) which is in charge of the operation of electricity-generating plants and its distribution within the country (except for the central states of the country that are supplied by Luz y Fuerza del Centro); and Pemex (Petróleos Mexicanos) which is in charge of the exploitation, extraction, transportation and marketing of crude petroleum and natural gas, as well as the refining and distribution of oil products and petrochemicals.

Regarding Transportation, according to the National Economies Encyclopedia (2007), the highway network in Mexico is the most extensive in Latin America: 235,670 km paved: 116,751 km (includes 6,144 km of expressways) unpaved: 118,919 km in 2004 (CIA, 2007). The railway is still inefficient to meet economic demands of transportation: 17,665 km standard gauge: 17,665 km 1.435-m gauge at 2006 (CIA, 2007). Most of the rail network is mainly used for merchandise or industrial shipments and was mostly operated by FNM (Ferrocarriles Nacionales de Mexico) that was privatized in 1997. At 2007, Mexico had 1,603 airports over 3,047 m: 1 1,524 to 2,437 m: 63 914 to 1,523 m: 408 under 914 m: 1,131 (CIA, 2007). The Mexico City International Airport remains the largest in Latin America and the 44th largest in the world. There are more than 70 domestic airline companies of which only two are known internationally: Aeromexico and Mexicana.

About communications, in Mexico the most important enterprise (almost a monopoly) is Telmex (Teléfonos de México) which was privatized in 1990. This company has extended its operations through many countries along Latin America and also in some parts of the United States. The telecommunication industry is regulated by the government through Cofetel (Comisión Federal de Telecomunicaciones). The use of other kind of communications, such as radio, television and internet in Mexico is also important: At 2007, there were 850 AM and 545 FM radio broadcast stations; 31 million of radios; 236 television broadcast stations; 25.6 millions of televisions; for 2000 there were 51 internet service providers, and at 2007 there were 7629 million of internet hosts and about 22 million of internet users (CIA, 2007).
Socio-Political characteristics of Mexico

Mexico is one of the most populated countries in the world, with a total population of 103.3 million people, occupying the eleventh place (INEGI, 2005). As many of the emerging countries are predominantly young, the middle age in Mexico at 2005 was 24 years old. The 31.5% of the population is from 0 to 14 years old, this is almost 34 million of people, 62.19 millions are between 15 and 60 years old and only 8.57 millions are older than 60 years old (INEGI, 2005).

In terms of education, Mexico has made great strides in improving access to education and literacy over the past decades, the illiteracy rate has diminished from 9.5 in 2000 to 8.4 in 2005 (INEGI, 2005).

About the political life, since 2000, Mexico has been experiencing a transformation on their political structure with the election of Vicente Fox the candidate of PAN (Partido Acción Nacional), followed in 2006 by President Felipe Calderon from the same party. The last administration has faced resistance from the left-of-center “Partido de la Revolución Democrática” (PRD) not only at the election process but also in each purpose of reform launched by the President.

Mexico is facing a frontal fight with the insecurity; President Calderon has made public security a focus of his presidency and has launched aggressive operations against organized crime and drug traffickers, and has also been willing to deploy the Mexican Army in the states where the cartels are dominant. The current administration is working on creating a favorable business environment for investing in the country, according to President Calderon’s self words.

3.3. Technology

It is important to define the term technology and to clearly differentiate from science and product. The etymology of the term “technology” comes from the Greek word “technos” (the process for doing something) and “ology” (systematic understanding of something).
So technology is the knowledge of a functional technique (Betz, 1998), it is the *know how*, a multifaceted capability.

The definition given by the Britannic Encyclopedia (2008) can be summarized as: “The application of scientific knowledge to the practical aims of human life”; which is consistent with the definition given by Betz (1998): “Technology is the knowledge of the manipulation of nature for human purposes”.

In contrast, science is concerned with the physical world and its phenomena, it involves a pursuit of knowledge (Britannic Encyclopedia, 2008), the *know why*; and products are a singular application of technology.

For the purpose of this research, a technology will be understood as the *set of knowledge, techniques and processes that can be applied for the design and construction of products or services to satisfy human needs*.

### 3.3.1. Technology Maturity

Technology emerges from the knowledge generated by science and engineering, it grows from initial development of research and development and continues to develop until it reaches the physical limit. The pattern of technology performance over time is usually similar for most technologies: it has an initial exponential growth in progress, followed by a linear growth in progress and finally, asymptotically leveling off to little or no progress. The form of this plot looks like an S, hence its name “technology S-curve” (Betz, 1998).

In general, it can be seen four phases for technology development: embryonic, growth, maturity and obsolesce (Figure 8).
It is important to understand the pattern of technology development, since for the proposal presented in this thesis, technologies suitable to be commercialized in the form of products and/or services in Developing or Emerging markets are those that are in their maturity or saturation stage. In the next section it will be defined the term Emerging Technology as used in this document in order to best understand the terminology employed.

3.3.2. Emerging Technologies

There is no standard definition of an emerging technology. Emerging technologies are often taken to mean science-base innovations that are at the forefront of technological innovations and research. For the scientific community, emerging technologies are those technologies rising from research and development, such as Nanotechnology, Biotechnology, Information Technology, Cognitive Science, Robotics, Artificial Intelligence, etc. (Roco and Bainbridg 2002).
Day et al (2000) include in the classification of emerging technologies those derived from radical innovations (for example, biotherapeutics, portable computers, etc) but also more evolutionary technologies formed by the convergence of previously separate research branches (for example, faxing, Internet, etc).

According to Vine (2000), emerging technologies are those that have not been commercialized but are liable to be commercialized within a medium period of time, or those technologies that are commercialized but they are not common yet or have not reached high levels of penetration to the market. In this connotation, developments in energy field, computer hardware and software, biological imaging, between others can be considered as emerging technologies also.

Compared to established technologies, emerging technologies (as well as their scientific basis and applications) are uncertain as they are evolving, and their functions or benefits have not been fully experienced. Their potential is mostly unfulfilled as evidence by a lack of significant products or services, and possibly by the lack of market demand or need.

It is important to highlight that for the purpose of this research the definition most suitable is the given by Vine (2000): “those technologies that are commercialized but they are not common yet or have not reached high levels of penetration to the market”. In this connotation, the emergency or newness of a technology will depend upon the market were it is intended to enter.

For the case of this research, we are going to consider “emerging technologies” the all spectrum of \textit{technological advances that are new to each emerging market analyzed by the methodology}.

3.3.3. Challenges related with Emerging Technologies

Day et al (2000) establish the differences between established and emerging technologies from the entrepreneur view (see \textit{Table 1}).
While established technologies benefit from technology, infrastructure, customers, and industry reasonably well defined, emerging technologies has to deal with imperative necessities such as lack of specialized skills, uncertain knowledge about potential functions or benefits, shortage of infrastructure, deficiencies on knowledge of potential customers as well as market’s unawareness in relation to the subject.

The biggest challenges to be faced by emerging technologies industry has to do with: the accelerating technology innovation, a great uncertainty and complexity, and also the need of developing new competencies (Day et al, 2000). The challenge is not only about identifying these technologies and their applications, but also is highly correlated with the prejudices and limitations of enterprises; thought pattern is a kind of “cognitive risk” and a kind of “cultural risk”.

As knowledge base is expanding for emerging technologies and the application to existing markets is undergoing innovation, new markets can be reached or created.
They have a big potential to create new industries or transform existing ones. According to Day et al (2000), each of these technologies offers a rich source of market opportunities that provides the incentive for risk investments.

The use of emerging technologies for the design of products demands new skills, new ways of thinking and innovative managerial approach to cope an eventually prevail. Creative ideas breed new ideas, and through time and technological growth, the innovative cycle and changes are accelerated (Myers, 2006).

3.4. Technology Monitoring

As proposed in the literature review structure, it is important for this research the definition and identification of techniques and methods for the monitoring of technology trends. Since the departure point of the methodology to be proposed in this thesis is not the development but the identification and utilization of emerging technologies (for specific markets) in the form of products, it is important to include some techniques to screen the technological environment in order to decide which technologies could have a better impact on specific emerging markets. In the next paragraphs some tools in the literature for this purpose will be presented.

3.4.1. Technology Intelligence

The technology intelligence consists on the technology-related information that is useful and utilized by product developers. An important issue to address is how to get and use the information outside to decide which technology is ready and convenient for product-development, and which industry to enter first with a new technology.

Technology intelligence arises from technical data but is embedded with interpretation and judgment by decision makers. A large amount of data is usually available about various technologies and technological environments. When a developer interprets the data, it becomes information, and the information can be transformed into intelligence.
3.4.2. Technology Mapping

Mapping technology environment refers to the process of gathering external data and analyzing it to derive intelligence for major strategic decisions. Conceptually, the process consists of three interlinked steps: scanning the environment to detect ongoing and emerging change and monitoring specific environmental trends and patterns to determine their evolution; forecasting the future direction of environmental changes; and assessing the current and future environmental changes for their strategy and organizational implications (Phillips, 2001).

a) Technology scanning and monitoring.

Developers must frequently scan the environment in order to identify indicators or precursors of current and/or potential change and issues in the technological environment. Technology scanning is focused on the inspection for applicable technologies, screening them for cost-effectiveness, competitive advantage and technological maturity. Phillips (2001) proposes some sources of technologies according to the stage of development (Table 2):

<table>
<thead>
<tr>
<th>Stage of development</th>
<th>Sources</th>
</tr>
</thead>
<tbody>
<tr>
<td>Scientific Research</td>
<td>Internet, Universities, and Scientific conferences and journals.</td>
</tr>
<tr>
<td>Technology Development</td>
<td>University-Industry workshops, Patent searches, engineering conferences and Technology Transfer organizations.</td>
</tr>
<tr>
<td>Product Development</td>
<td>Competitive Intelligence methods and societies, and Incubator associations.</td>
</tr>
</tbody>
</table>

*Table 2. Technology Scanning (Phillips, 2001)*

The monitoring of data is more focused and systematic than the scanning. The search of data is usually guided by prior hunches generated during the scanning or brought to the developer’s attention by consultants or academics.
b) Technology Forecasting

According to Phillips (2001), technology forecasting describes and identifies the rate, direction and implications of change, with the objectives of anticipating change by means of a definition and communication of technical realities and environment that will allow the anticipation and distinguish between possible, probable and preferable futures. Technology forecasting looks at the timing, function and cost of new technology.

Technology forecasting exercises should have a clearly stated objective, schedule, scope and methodological approach. There are some useful tools to forecast technology (Vaston; cited on Phillips, 2001):

- **Surveillance**, that includes scanning the environment, monitoring and tracking developments, in order to examine existing technologies and their modifications, as well as look for new technologies entering the market.

- **Projective**, that includes tools as trend extrapolation, substitution analysis, and examination of historical precursors of a current trend. Projective tools are based on the theory that the future will be very much like the past.

- **Normative**, are tools that ask users to set goals for the future and to design a plan to meet them. These tools include focus groups, morphological analysis and interviews.

- **Expert opinion**, single individuals, surveys or group formats that draw on the intuition and beliefs of leaders in the field.

- **Integrative**, this tool is a combination of the other four tools, attempting to collapse all the information into a coherent planning process, for example the scenario planning.

The use of these tools and methods was studied in order to identify which of them can be more useful for the entrepreneur who is willing to construct a business opportunity in a specific market. It is important to notice that the aim of this methodology is not to give a step by step method for analyzing technology trends, it is instead to explain what kind of tools are being used by technologist to have a panorama of the future of technological
Chapter 3. Literature Review

advances and focuses. The information provided in this literature research will give entrepreneurs gears for deciding which information is more reliable according to their expectations.

3.5. Product Realization

Product realization is the transformation of a market opportunity and a set of assumptions about product technology into product availability for sale (Lopez, 2007), it comprises since the design, development, manufacture and delivering of finished goods of services to a costumer.

The product realization is an ancient activity. Since the prehistoric age men and women had to imagine, design and build artifacts to help them in the daily satisfaction of their necessities. Those artifacts were evolving into more specialized and hence, complex instruments. As population was growing up, societies were developing and more products were bringing out, not only to satisfy the necessities of a person, but of a group of persons.

Having well done products ready for everyone was gaining importance in societies, first obtained from artisanal works, and later from methods of serial production. Machines were designed also to produce them, and a single person could not manage a complete project because he could not have the knowledge, training and time enough to make it.

As the complexity of design and development of products was increasing, groups of specialized people were appearing on areas as Marketing, Design, Manufacturing, Management, Research and Development. This evolution brought whit it the loss of communication and interaction between people involved in the design, manufacturing and marketing processes, as well as between researchers and practitioners.

elements of the life cycle of products since its concept to its decommission; these disciplines are strongly related or were conceived for the global process or set of activities required for the realization of new products.

Product design is one of the most crucial parts of the product realization, since in this stage the minimum part of total costs of product realization is incurred, and in is the most impacting stage of the product life cycle because improvements in this stage impact strongly on latter stages of manufacturing and selling.

3.5.1. Product Design

The success of a new product launch into the marketplace is determined not only by the technical characteristics of the product but also by a set of strategic factors that will help ensure its market success. Involving customers in the innovation process or the product design and development process can perhaps be the easiest way of increasing quality, decreasing cost, and speeding the product development time.

Although it cannot be considered in detail all the activities required to be performed during the process of product development, some methodologies have demonstrated an improving of time, quality and cost in all different disciplines. The common stages of product design processes are going to be explained in the next section.

3.5.2. Product Design Process

The process of Product Design can be defined as complex activities system that produces the required information to carry on the products resulted of a market opportunity to their manufacturing (Otto and Wood, 2001). The Product Design begins with an abstract and confusing description of a new product, and it varies according the intrinsic characteristics of the market, the industry, and the product itself. Nevertheless the typical sequence of activities can be included in the following stages (Molina, et al, 2007), as depicted in Figure 9.
Product Idea (Conceptualization): This is a description of the form, function, and features of the product. In this stage, the needs of the target market are identified, alternative product concepts are generated and evaluated, and a single concept is selected for further development (conceptual design). In this step the technology infusion into new product takes place. The product idea includes the generation of guide specification, design requirements, programming of preliminary plans, etc.

Basic Design: The basic design consists of the definition of the product architecture and the division of the product into components and subsystems. Basic development is the identification of essential problems by the establishment of function structures and by the search for appropriate solution principles.

Advanced Design (Detail Design): this is the stage of the design process in which the arrangement, form, dimensions and surface properties of all individual parts are finally laid down, the materials specified, the technical and economic feasibility rechecked and all the drawings and other production documents are produced.

Prototype (Launching): the purpose in this phase is to resolve any remaining problems in the prototype construction. Moreover, tests are carried out to check the functionality and potential design modifications.

The focus of this research resides on the first stage of the product design process, the product idea or conceptualization of the product, which is the stage where the product idea is generated and where innovation and creativity strongly take place.


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3.6. Product Idea

According to Gruenwald (1992), “conception is the inoculation of a germ of an idea, giving it sufficient shape to recognize its possible potential. To begin, input is required—something must come from something. With input, ideation is spawned. With ideas, forms become concrete”. For product ideation, input can come from many sources.

There is a variety of ways product idea can be generated. For the most of the techniques proposed by the literature, listening to the customer is a very important part of generating the idea, and screening is a very important part of taking action. Annacchino (2007) classifies venues for new product idea generation:

Customer-defined needs and wants: Surveys to customers, focused group discussions, suggestion systems and communication from customers and customer complaints, are typically techniques utilized to identify customer’s wants and needs.

Generated by company members: Company dealers and representatives ideas (resulted of client’s feedback), top management driven ideas, etc.

Scientific research: The creations of novel or advanced devices or products are typically a result of scientific research and development: Inventors and patents, gurus and geniuses, etc. Technological Research aims to invent artifacts or processes with the objective of offering them to the market and obtain economical benefit.

Miscellaneous sources: Observation of problems, competitor’s products, listening, licensing, and trade schools, etc.

There are many sources of product ideas, and where they came from is not as important as the evaluation and selection of suitable ideas. There are several techniques for generating product ideas (Annacchino, 2007), (Gruenwald, 1992):

Brainstorming: Generation of ideas in a free-flow fashion. It involves getting a group together for an informal sharing of ideas that can come from designers, salesman, employees, etc.
Chapter 3. Literature Review

*Attribute listing:* This method consist on the generation of a list of the major attributes of an existing product and modifying each one by generating new combination to improve the product or secure a new niche.

*Forced relationships:* It consist on the combination in a single product of diverse functionalities of several products simultaneously.

*Peer group:* A group of experienced professionals eager to share experiences and perceptions of the category with their peers stimulates ideation.

*Delphi:* Tersine and Riggs cited on Gruenwald (1992) propose the next definition for this technique: “It’s a method to systematically solicit, collect, evaluate and tabulate independent opinion without group discussion”.

### 3.7. Innovation Processes

According to Narayanan (2001) two different types of innovation processes may occur: Market-pull and Technology-push; in the former, the advancement of technology is oriented primarily toward a specific market need, and only secondarily toward increased technical performance, and in the latter it is oriented toward increased technical performance, and only secondarily toward specific market needs. These two approaches correspond with the first two generations of innovation models of the 1960s and early 1970s, three more generations for industrial innovation have been developed, the third generation consisted on a coupling model at the late 1970s to early 1980 to the integrated model, the 5th generation model, innovation is becoming faster including company networking and using electronic toolkits (Rothwell, 2007). Nevertheless those three last generations are not focus of this research due to their industrial focus, they are more complex and have been developed for enterprises ’systems of innovation and are not adequate for new ventures.

According to Narayanan (2001), the key task in management of technology is to link technological solutions to the needs of the marketplace.
Methods based on the Market-Pull approach: In the market-pull innovation, the idea for innovation originates with communication about a customer need, followed by a search for technical solutions to meet that need. This is the generic process of development of products. In this approach the developer begins with a market opportunity, and then finds an appropriate technology to meet customer needs.

Methods based on the Technology-Push approach: In the technology-push innovation, the opportunity presented by a new technological advance stimulates a firm’s search for an application. The design of the product begins with a new technology, and then the developer finds an appropriate market. The task of matching technology and market should be done, and the concept development assumes a given technology.

Nevertheless, when these views are presented to developers as opposites, they force them to choose between either conducting long term, speculative research based on technology-push approach, or short-term customer-oriented development projects that present little risks but that may not take advantage of the technological development. Subsequently, neither of these approaches alone describes what successful innovators actually do.

According to Jolly (1997), a better approach is one that merges and integrates the advantages of both views, taking advantage of the technological innovation as a segmented process where each segment requires an integrated approach (research development, engineering, manufacturing and marketing where necessary) to come up with a valuable outcome.

3.8. Technology Appraisal according to Kozmetsky and Kilcrease

The technology appraisal method analyze opportunities related to new technologies, it is used by the NASA Technology Commercialization Centers, as a part of their task of incubating new business based on NASA technologies.
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This method involves the identification of the product market where the innovation may represent a profit opportunity; the identification of complementary technologies; the choosing of the industry or market that best justifies an initial push to product development; and the identification of the firms that are potential licensees or partners in new consortia for product development" (Phillips, 2001).

The technology appraisal procedure designed by Kozmetsky and Kilcrease 1994 (cited in Phillips, 2001), consist on the following steps and activities (Table 3):

<table>
<thead>
<tr>
<th>Step</th>
<th>Tasks</th>
</tr>
</thead>
<tbody>
<tr>
<td>Brainstorm of potential markets</td>
<td>▪ In the first phase the focus on the fit between technology and a real or potential market need is made, and can be repeated as needed.</td>
</tr>
</tbody>
</table>
| Identification of product characteristics of each market | ▪ The way the technology might be embodied in a product or service is traced.  
▪ Features/specifications/benefits definition. |
| Research and analyze current situation in each market, independent of new technology | ▪ Identification of the industry/es which currently serve each market  
▪ Determination of market size, growth rate trends, channels, pricing; competitors  
▪ Exploration of customer needs, perceptions, buying behavior; technological regime and levels of technical and market uncertainty. |
| Determine whether there is a real or perceived need in the selected market for the proposed new product | ▪ Determine the value of the new product to potential customers |
| Identify factors necessary to bring the proposed new product to each market | ▪ Analyze barriers to entry  
▪ Identify necessary complementary assets and capabilities |
| Determine the impact of the new product’s entry | ▪ Determine the nature of the innovation and its impact on the technical regime, market power, etc. |

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| Determine the best market entry | • Analyze relevant organizational factors and strategic factors. |

**Table 3. Kozmetsky and Kilcrease technology appraisal procedure (In Phillips, 2001)**

The technology appraisal procedure in Table 3 begins from the technology identification, understanding and assessment of the technology and an analysis of the market, and then actions are taken in order to best fit market’s opportunities.

Nevertheless, this approach of this methodology is technology driven though with the confidence that markets can usually be found.

**3.9. Technology Commercialization according to Jolly**

In contrast to the technology appraisal that follows the traditional approach which emphasize a linear progression from research, through development, to engineering, production and marketing, Jolly (1997) recognizes that some technologies fail because they are integrated to products for which the anticipated demand never materializes, others continue to search for suitable products, sometimes over decades, without being incorporated at all.

Jolly’s approach is a complete process that comprises all the necessary stages for accomplish thriving technology commercialization. It has as input a scientific or technological development that will be introduced to a market in the form of products. This approach’s output is the generation of long-term value by establishing and expanding use of the technology and retaining a lead in it for developers.

Jolly conceives the technology commercialization as a dynamic process that proceeds through five stages: 1) imagining a techno-market insight; 2) incubating the technology to define its commerciability; 3) demonstrating it contextually in products and/or processes; 4) promoting the latter’s adoption; and 5) sustaining commercialization (see Figure 10). The five sub processes aim to build the value of a new technology, supported by four bridges that provide them the feedback necessary to generate value for stake holders at each stage.
Under the conceptualization of this author, the success of technology commercialization depends on the structured performance of a range of things, each adding value to the technology. For each technology’s evolution stage, Jolly identifies the main functions, value outcomes, resources and required stakeholders as key elements to achieve success.

The Imagining, Incubating and Demonstrating sub processes deals with the product development since the ideation, or conceptualization to the launching of a product. Imagining consist on getting a new idea recognized and authorized to be worth pursuing. Incubation gives the definition of the idea’s technical feasibility as well as the commercial potential, and the plan for taking it further which represents an important filter for product ideas that could not achieve success, and also provides valuable inputs for the “Demonstrating” sub process (basic and advanced design and prototyping). And the last two sub processes (Promoting and Sustaining) deals with the traditional bringing to market (manufacturing and marketing).

Moreover, bridges offered by Jolly enriches the process as it considers information not only technical or scientifically, but also environmental, this is, it considers the inputs from potential customers or stakeholders of the technology and allows the enhancement of a better technology-based design that could be accepted by a market.
In Figure 11 it can be seen the relation between the Technology Commercialization process and the Product Design Process described before. As can be seen the sub processes of promoting and sustaining is not considered traditionally in product development processes.

![Figure 11. Relation between Product Design process and Technology Commercialization process](image)

As mentioned before, the focus of this research is the product idea; this is why the Jolly’s sub processes that are more important for this thesis are the Imagining and Incubating stages.

Figure 12 portrays the content of each sub process (or commercialization stage) in terms of the technology exploration, or maturity development of technology; market exploration as the necessary inputs from potential customers; and the context of research which must be in the focus of product developers.
The first part refers to the pre-commercial stage which is typically motivated by past knowledge, the curiosity of a researcher or an organization's wishes to develop for the future, etc. The commercial value triggers at the imagining phase which is going to be presented in the next section.

3.9.1. Imagining

From the beginning, the technology commercialization approach focuses on the benefits of a fundamental “dual insight” through the commitment to scientific rigor and market orientation. The first approach consists of imagining a new device, application or product to focus the research on it.
The motivation for research can provide from an idea for a new product, in which the specification of the product determine the technological path to be taken; it can be also provoked for a solution for a problem for which there are no product idea in the beginning, and by means of the research it is meant to develop the technological capability to generate a product to solve it; the reaction to competitors or the intention of exploiting new principles to build a capability can also prompt research.

No matter which of these reasons has triggered an organization’s research effort, commercially valuable ideas can be achieved by researchers by three ways: pursuing deeply and thoroughly a specific problem, being prepared for serendipitous events or alternating between the technology and its applications purposefully.

According to Jolly, it is not proper to consider innovation as a purely “market-pull” or “technology push” approach. Instead, a better way for achieving innovation is by alternating both. Good inventors have the capacity to engage alternatively in both types of problem solving, by one side searching for context while the technology itself is being explored, but also looking for technology to solve market needs. “More important than which dimension leads innovation is maintaining a commercial focus throughout” (Jolly, 1997).

Although exploration in this stage is proposed as an iterative process in Figure 12, it has to stop sometime and a Techno-Market vision must be quickly set in order to create a worthy idea to be commercialized. Jolly states that there are three ways to accelerate the process of coming to a technology-market insight:

1. By accelerating the rate of experimentation using brainstorming and formal creativity techniques involving the participation of multidisciplinary group of individuals.
2. Grounding the research in known problems, keeping a problem context in mind from the beginning; “the more research is allowed to proceed deeply in a recognized problem area, the quicker and often better the outcome”.
3. Intensifying contacts between researchers and the market in order to anticipate new uses; under the argument “the more people talk to one another and exchange ideas, the greater the cancels that creative technical insights will
emerge and be linked to market opportunities that the original proposer may not have thought of”.

Jolly summarizes the important actions that should be considered in the first task of technology commercialization as following:

*Both for research managers within companies and for government agencies, this [managing the process of idea creation effectively] translates into:*

- *Providing as wide and rich a commercial context as possible, including scenarios of the future;*
- *Creating the conditions wherein chosen problems are pursued deeply and in a no obvious fashion for a while; and*
- *Encouraging contacts, brainstorms, and idea exchanges, rather than encouraging solitary, withdrawn research and skunk work over a long period of time. (Jolly, 1997)*

### 3.9.2. Incubating

The second process of the technology commercialization process proposed by Jolly (1997) is about incubating to define commerciability, and it is about deciding weather and how to take a technology further. This stage is an intermediate stage between an idea of a technology or technology application and the creation and launching of products to market.

The stage of incubation deals with taking the technological development further and exploring all possible applicable context and uses before deciding which option is the one with more potential as commercializable product, and also the definition of the size of the potential worthiness and the realization-feasibility probability within a reasonable time frame. Enhancing the value of the ideas generated in the first stage, or deciding as best option a later one is what incubating aims, in order to do so, this stage requires a full knowledge and understanding of markets needs and how the available technology fits.
Jolly proposes for generic inventions that developers must build confidence by showing that the technology progress will be fast enough to support the development of the applications that is being set out. Also, as many inventions have the potential to be used in more than one application, the reliability and attractiveness of each application contributes to the reliability and attractiveness of the others.

The search of application must consider the following approaches:

1. Looking beyond the initial context for which technology was developed.
2. Avoiding generating new applications related to future uses when the supposed context is not reliable enough.
3. Constructing a portfolio of potential applications, stipulating on which among these application will be pursued and when.

Many techniques exist to forecast technology trends, which must be done in parallel with market conditions’ forecasting.

The approach suggested by Jolly for “Screening for Attractive Applications” is divided in two principal levels: a first level consist in the removal of applications that have little business interest; and then evaluating the remaining ones and assign weights to determinate which applications are more convenient for a current development or a later development (see Figure 13).
The emphasis of the analysis of the technological application presented on the Figure 12 should be on making the technology attractive to commercialize in a rapid manner. Thus, applications of interest are the ones that are targeted to attractive markets and the skills and infrastructure enough are available for the developers. Equally important are the factors related to the technology itself, such as technical barriers and economical barriers.

The “Leveraging Existing Skills and Infrastructure” is not useful for this research since this methodology is intended for new ventures. In a similar manner, “Scope of Problems Addressed” screen will not be used because the purpose of this thesis is to develop commercializable technology-based products, instead of technologies.
CHAPTER 4. METHODOLOGY

4.1. Introduction

It has been demonstrated in many cases in the literature that the methodologies of product design and technology commercialization, as well as tools and techniques for innovation, creativity, clients’ needs monitoring, technology trends, etc., have contributed individually to the design and product development.

In this chapter, is the author’s purpose to present a methodology that integrates some aspects of the reviewed methodologies and some techniques in a structured way in order to facilitate the generation of an idea of a technological product to an enterprise or entrepreneur willing to make profit on an emerging market by solving a necessity by means of emerging technologies.

4.2. Generalities of the Methodology

This proposal has been denominated “Methodology for the Generation of Technology-based Product Ideas for Emerging Markets”. This methodology pretends to probe that the methods and techniques presented in the literature review can be instantiated and linked in such a way that they could give a path for successful ideas generation. The experience and knowledge obtained from the case studies developed at the research chair “Rapid Product Realization for Emerging Markets using Emerging Technologies” has also been useful for the development of this work.

One of the theoretical cornerstones of this research is the Technology Commercialization process developed by Jolly (1997), since the methodology attempts to focus its attention to the implementation of emerging technologies to the product ideas to be generated, with the purpose of contributing to the technological development from and for emerging markets.
Chapter 4. Methodology

The author have proposed the relation of this methodology in the frame of the Product Design processes (Molina et al, 2007), and also it has been presented it relation with the phases of the Technology Commercialization process (Jolly, 1997). It is believed by the author that those processes can be complementary to each other, since each one of them embraces a different perspective, the former in a technical sense while the later was developed with a more strategic focus.

From the analysis of both methodologies, it is not difficult to realize that on the one hand, since Technology Commercialization methodology is intended for people involved in research and technology development, be it in Universities, Research Centers, or Global Companies, they want to find the best way to make successful a technological advance and gain profit from it; on the other hand people developing Product Design or Product Development process is concerned with finding a product to commercialize (not precisely a technology).

After the study of some methodologies for product design, it has been noticed that the product design begins with an abstract and confusing description of a new product, there exists many gaps referring the tools that are used in the idea generation phase, which has an enormous importance since is in this phase where the product can be tailored as necessary in order to fit the market’s expectations. Is because of this that the initial effort in product conceptualization should integer the information concerning it technological environment, clients, and competences in order to assure the success of the product.

Another important point to highlight is the fact that for emerging markets it has not been developed a methodology for product ideation or conceptualization, which represents a huge lack for the enterprises and entrepreneurs when attempting to commercialize their products in those markets. The literature presents some successful cases where global companies, or even local companies, have obtained profit from designing products and services for emerging markets, their strategies and experiences gained will be incorporated to the methodology presented in this chapter.
4.3. Methodology for Technology-based Products for Emerging Markets

The methodology for technology-based products for emerging markets can be seen in the frame of the Technology Commercialization model given by Jolly as depicted in Figure 14. It can be seen that while this methodology fits in the first two sub processes of the frame (Imagining and Incubating), the Product Development fits more in the Demonstrating phase where the aim is to deliver products to the market in order to exhibit the technology, and latter the Business Plan formulation has to consider the Promoting and Sustaining aspects of the technological products in order to assure its solidity in the market.

![Figure 14. Frame of the methodology](image)

It is important to note that the process presented by Jolly (1997) in its general representation corresponds with the technology-push approach explained in chapter 3, that also matches with the first generation of the Innovation theory (Rothwell, 1994), with the distinction that for each phase it considers a strong interaction between the principal stakeholders, not only from the research environment but also from the market.

In the methodology proposed by the author, each of the first two sub processes of the Jolly’s frame will be considered in this work as the main stages. Each stage will keep the conceptual basis, recommendations and the understanding provided by the Jolly’s process. The technology appraisal methodology developed by Kozmetry and Kilcrease (1994, cited on Phillips, 2001) will be also used for giving a departing point for the structure of the processes in each stage, in which some specific activities will be proposed based on toolkits, techniques and methodologies from literature and cases.
Chapter 4. Methodology

The first stage will provide of a portfolio of ideas for potential products that will consist on the association of technology applications and the potential needs’ that could be satisfied by a product that integrates the functionalities of the technology. The second stage will have as a tollgate the generation of a prioritization of products according to its suitability to each market, its potential acceptance and prospective commercialization success. In both stages, it will be carried out the collection and manipulation of the information generated by primary and secondary sources of information from the technological environment as well as the market voice. All this information could be used by subsequent stages along the lifecycle of the product: the product, process and manufacturing system development and the business plan for its commercialization.

4.3.1. Generation a Portfolio of Product Ideas

In this stage, the methodology for the generation of a portfolio of product ideas is divided in three sub stages as it can be seen in Figure 15. The development area identification, selection of the focus market and the association between the technological applications and potential market needs is carried out in this stage.

![Figure 15. Generation of a Portfolio of Product Ideas](image)

The expected outcome is a set of unique technology-based ideas linked to a set of market needs, and the completion points will consist on a preliminary vision of those products.
The collection and analysis of information is the main task to iterate in this phase, and it has to be taken seriously and systematically, nevertheless it is important to keep in mind that “Getting to an idea worthy of commercialization as quickly as possible is an undeniable priority today” (Jolly, 1997).

4.3.1.1. Selection and Analysis of the Technological area for Development

As highlighted by Jolly (1997), a dual insight must be continuously considered between the technology environment monitoring and the market situation assessment. In this phase a little bit of technology reading is to be pursued, for which the identification and portrayal of the key players of the ideation of the product must be made in order to select a suitable technological area for the development of the project. Figure 16 depicts the main activities to be performed in this sub-stage.

![Selection and Analysis of Technological area for Development](image)
Chapter 4. Methodology

Selection of the participants for the project

The first sub stage is perhaps the most determinant stage of this methodology since is in this part where the developer has to select the technological area in which the innovation will take place, according to the core competences of the group of participants that will develop the project.

This identification of participants includes not only the selection of the group of entrepreneurs that will participate of the potential business opportunity, but also it has to be delimited the groups, institutions, research centers, technical associations, consultant associations, enterprises that could give support to the venture. There exist many researchers and technology developers in universities and research centers that are willing to participate on the identification of opportunities in order to apply their advances as will be shown in the case study.

Competences identification

According to Phan and Foo (2004) the process of opportunity search for emerging markets is heavily influenced by the entrepreneur’s background as well as the environment in which the entrepreneur finds himself. This is why the catalog of core technical competences that can be achieved will play an important role for the definition of the technological area most suitable for the project. This catalog has to take into consideration the competencies that can be aggregated from potential collaborators. The group of entrepreneurs has to decide the rank of the intangible assets present in the catalog in order to make the most with their own competences.

There has not been developed a concrete instrument for the identification and measurement of core competences of entrepreneurs, even when it has been noticed the necessity of measure competences and their development in a reliable and valid way. Nevertheless, some tentative procedures have been proposed for specific areas, according to Lans et al (2005).

Self-assessment procedures, peer-assessment procedures and expert-assessment procedures based on questionnaires can be used for the definition of personal and
technical competencies identification and measurement (Lans et al, 2005). The questionnaires have to consider aspects related to:

- Personal and business interests: compromises, type of business intended, and ultimate goals of the entrepreneurs.
- Technical background: issues related with their education and work experience.

Selection of the technological area for the development of the project

Once identified and understood the core technical competencies of the group that will develop the ideation, design and development of the product, it is important to select the technological area for the development of the project according to the competencies identified. Developers can make use of the information published in the media; it is not difficult to get news about the concerns and expectations in the global environment.

Documents of technological and social trends can be useful for this purpose. The collection of this information can be obtained by internet on official electronic documents provided by the governments (e.g. Plan Nacional de Desarrollo 2007-2012) or global institutions (e.g. OECD Reports) and also from printed literature (e.g. Forbes Magazine). There are being published several books addressing what some authors call “Megatrends” that comprises not only technological but also political, social and cultural trends, and also many information about prospective can be found (e.g. “Megatrends 2000” by John Naisbitt and Patricia Aberdeen).

In the ITESM Campus Monterrey, there has been developed a web portal that gives to the ITESM community access to social and technological megatrends, and it gives the information concerning prospected applications of those megatrends for potential business opportunities (OET, 2008).

Collection of information about the technology

The identification of information sources is important in order to get trustworthy information for decision making. According to Escorsa and Rodriguez (2000), it is important not to incur in the excess of information, or in the incorrect focus of
information. The selection of the information sources depends on the necessities of the users and the technical area selected and the available resources. In Table 4 the main Science and Technology information sources are exposed.

<table>
<thead>
<tr>
<th>Classification</th>
<th>Sources</th>
</tr>
</thead>
<tbody>
<tr>
<td>Observation in the</td>
<td>• Analysis of technology of first hand (for example reverse engineering).</td>
</tr>
<tr>
<td>technological field</td>
<td>• Short stances or visits to technology developers.</td>
</tr>
<tr>
<td>Experts</td>
<td>• Professional relations with researchers and developers</td>
</tr>
<tr>
<td></td>
<td>• Informal meetings with technicians</td>
</tr>
<tr>
<td></td>
<td>• Consultancy</td>
</tr>
<tr>
<td></td>
<td>• Contracts with specialists</td>
</tr>
<tr>
<td>Technical and</td>
<td>• Publications in specialized journals and magazines, patents, reports, etc.</td>
</tr>
<tr>
<td>Business Literature</td>
<td>• Not published reports</td>
</tr>
<tr>
<td></td>
<td>• Informative data bases from government, companies, associations, etc.</td>
</tr>
<tr>
<td>Organizational</td>
<td>• Technical conferences, meetings and fairs</td>
</tr>
<tr>
<td>Contacts</td>
<td>• Professional contacts (associations)</td>
</tr>
<tr>
<td></td>
<td>• Participation in international organizations or industrial associations</td>
</tr>
</tbody>
</table>

*Table 4. Principal sources of information about Science and Technology (From Ashton and Stacey, 1995; cited at Escorsa and Rodriguez, 2000)*

The observation and the organizational contacts are the first sources of information for this methodology in which the information and knowledge obtained will be useful for giving an initial direction for the information acquisition. The identification of the experts in the selected development area must be done as a primary source of information.
It is important to plan the way in which the information will be gathered from them, this means, that is important to define and plan the questionnaires and interviews in order to get the expected level of information and to avoid to drive their responses. The gathering of this information has to be planned in order to get precise and concise data that could be converted in useful information and knowledge.

Once collected information from direct resources, the secondary sources of information can be selected and taken advantage with support of the experts of the technical area. Important and relevant key words can be retrieved from them and this can accelerate and optimize the search process. Technology trends and relevant information can be found and downloaded from the web and recognized databases. Patents’ generation can be found by using search motors as the one provided by Google (Google patents, 2008), one can get advantage from the advanced search option of this site (e.g. narrowing the period of time for the patents issued).

**Analysis and interpretation of information**

The information is classified and filtered in order to compile and sort it and give a preliminary list of feasible emerging technologies’ applications. The focus of this activity is to analyze the research data generated from the previous task by recognizing relationships, patterns and insights.

There is not a global established technique for data analysis, nevertheless there are various tools that could be employed for this goal, and the selection of it depends on the task, the data collected, and the experience of the methodology runner.

One of the most important recommendations for this activity is the slow and careful reading of all materials usually more than once, reviewing the materials in different ways (by source, by topic, by time) and assembling the facts also in various ways so that one or more logical pictures begin to emerge (McGonable and Vella, 1999). Under this approach, some techniques can support the analysis and interpretation of data that can be used for the analysis of data from the technical environment but also for the market understanding (McGonable and Vella, 1999) (Kumar, 2004):
• Context Data Analysis: The analyst searches for key words that are linked to key concepts, events or strategies and structures the related data creating overview patterns of associations, flows, historical developments and value exchanges.

• List Sorting: The analyst arrange lists of data by creating clusters based on relations and showing patterns in diagrams such as matrix, maps, trees and profiles.

• Charting/Mapping: This is a process that provides visual aid to the analyst, which takes data on one or more index cards and converts them to a graphic form to bring out existing relationships or patterns.

• Forecasting: The analyst assembles the information and data and by means of cause and effect diagrams and analogies with similar situations to identify trends in the technical environment.

Technical Intelligence makes emphasis on two techniques for technical information analysis: patents’ analysis and scientiometrics. According to Rodriguez (2003), the analysis of patents represents one of the most important means for the definition of the path followed by the technological development in a selected sector. A patent is a property right given by a government for an invention and its scope is limited to the country that emitted it. Patents can be used for the determination of the level of technology of a country and the spreading out level of a technology (Mogue, 1997).

Scientometrics is focused to the measurement and intelligent utilization of the scientific and technical development by analyzing the available computerized and technical information. The co word analysis employed by scientometrics techniques is useful for technology mapping in order to identify technology trends (Courtial et al, 1997).

The selection of the analysis technique is decision of the analyst; it is important to consider the complexity of the information gathered, the scope of the project and the experience of the analyst. It has to be noticed that methods of scientiometrics are useful when the complexity of the information is large and it is difficult to read all the information, these techniques can be assisted by the use of computerized programs (e.g. Leximappe Software), nevertheless the intelligence process should be done by the human intellect.
The important issues to identify from this stage are presented below:

- Technology map to see the mature level of the technologies in the area.
- Spectrum of proved applications of those technologies.
- New applications for mature technologies in the field.
- Advancement of the development of the technological field in countries.

### 4.3.1.2. Selection and Analysis of an Emerging Market

This stage has to deal with the identification of a potential market in which the development area has been selected. It is important to analyze and compare between emerging economies and regions in order to have enough tools for the selection of an emerging market. Other considerations that have to do with some particular interests of the entrepreneur can be evaluated, but it is important to have a serious foundation for the selection of an emerging market. Figure 17 depicts the activities to be developed in this sub-stage.

*Figure 17. Selection and Analysis of an Emerging Market*
Chapter 4. Methodology

The purpose of this stage is to narrow the search of information to one market, as this research is focused on emerging markets, it is helpful to select a geographical area due to the regional differences between population in those economies.

Selection of an Emerging Market

The study population can be delimited according to:

- The project group interests and scope, in cases when the methodology runner is committed with the development of a specific emerging economy.
- The natural conditions and features of the technological area selected, for example solar energy can better be used in regions where the isolation is high.
- The technological development of the subject in the region, the existence of universities and research centers focused on the selected technology in a geographical area can make cheaper the product design and development, as well as they can accelerate the education of the market on the use and benefits of the emerging technology.

In the last decades more and more information about emerging economies have been produced and published, it is not difficult to find information about the scarcities, requirements of technological development of those countries. As mentioned in chapter 3, emerging economies are characterized by the diversity of its regions; the economical, technological and educational development on them is not equally distributed. Therefore the selection of the market is not limited to a country, but a region.

Collection of information about the market

As for the collection of information about the technological development, the selection of trustworthy information sources for a selected market is of vital importance in this stage. They have to address concerns about the trends of the population and the potential needs that could be tackled with the selected development area’s applications identified in the previous sub stage.
Primary information sources play an important role for the market’s necessities research, because is by the identification of experts in the selected region that the market-reading can be accelerated. Sociologists from local universities and regional authorities can support this effort, for instance, in Mexico the Forums for Citizens’ Consultancy (Foros de Consulta Ciudadana) are made in each town by municipal authorities. This event is carried on at least once in a year with the main purpose of knowing the necessities of the inhabitants (infrastructure, education, health, public services, etc.).

Secondary sources of information are published (printed and electronically) by periodical national and international reports in the selected area (e.g. energetic trends given by Energy Departments in each country). Statistics (e.g. INEGI in Mexico), international and regional trends (e.g. OECD Reports), national and regional development plans (e.g. SEDESOL in Mexico) can also be founded in the Internet which represents an important source of secondary information. Special databases for emerging markets can be founded in the WEB (e.g. ISI Emerging markets) that provides access to newspaper collections, articles, statistical resources, etc.

It is recommendable the registration of all the information gathered, this can be made with the help of a computerized data-base that could allow the information structuring, and retrieval for further purposes in the project.

Analysis and interpretation of information

The filter and codification of this information as well as its understanding and dissemination in the group is very important. Some techniques such as affinity diagrams can be useful for the analysis activities, as well as the previously described (context data analysis, list sorting, charting/mapping, and forecasting). The aim of this activity is to make an inventory and classification of the market’s needs, as well as the classification of information about the market that can be used in the incubating stage of the project.

The listing of market’s needs must consider not only those current shortages or necessities, but also those that could result from forecasting a future condition of the
market. The most important outcome of this activity is to get an essential understanding of the market’s needs, culture, wishes, habits, values and customs.

As developing markets are moving target, it is important to look for patterns of change (e.g. as they emerge to the developed world as the case of BRICS), as well as the “growing pains” that are often related with this path to development: political and economic turbulence, strains on fragile infrastructure and environmental changes. Furthermore, developing and emerging markets population is in its majority young, consequently it is important to focus on youthful necessities and requirements, understanding who have the most political and economic power. Identification of migration patterns into the cities, recognizance of opportunities for education and understanding of the changing roles of the women can also give idea of potential necessities that can arise in those markets (Mahajan and Banga, 2006).

### 4.3.1.3. Link between technologies and the market

The exploration of all possible applicable contexts can be done by reinforcing the contact between developers and the market. The analysis and understanding of the information generated in the previous stages is the principal input for this sub stage. In Figure 18 are depicted the main inputs and outputs of this sub-stage.

*Figure 18. Link between Technologies and the Market*
Many techniques and recommendations can be applied to achieve this purpose; the proposed are the following ones mentioned by Jolly (1997) that are complementary between them:

- Brainstorm: The use of brainstorming and formal creativity techniques between the entrepreneurs with the collaboration of supporting researchers and experts in the technology can accelerate the search for potential applications to the technology features. Brainstorming is one of the most known and used technique for finding solutions for specific problems using all the ideas given by the participants. For this technique is recommended a group of 6-7 persons (no necessarily experts), in one session of brainstorming the group must produce ideas while a moderator writes them in a board, in such a way that the emitted ideas can serve as stimulus for the generation of new ideas. At the end of each session of brainstorming, the moderator (methodology runner for our purpose), after a deep reflection, keeps the ones that appears to be more interesting and the group to clarify and extend those that they think are interesting. Finally a prioritization is done with the help of the group (Cegarra, 2005).

- Nominal Group Technique (NGT): This is an alternative to brainstorming; it uses a more structured format. One of the most important benefits of the NGT is the neutralization of status and verbal dominance among group members, allowing those reluctant members to enhance their participation in the group. According to Moore (1987), the ideal size of an NGT group is 5 to 9 members (and a group leader), and it typically includes four steps, beginning with a silent (and independently) generation of ideas in writing; a round-robin recording of ideas, where each participant contributes a single idea each time that is recorded on a large flip-chart (without permitting discussion of the ideas); once the group determines that they have produced a sufficient number of ideas, a serial discussion of the list of ideas is started in order to clarify all of them; the last step of this techniques is the voting, where the participants identify the most important ideas and anonymously votes for the best one.
• Grounding the Exploration: As proposed by Jolly (1997) grounding the research in a specific context can accelerate the ideas generation, this is providing to the brainstorming group with some insights to help the process of generation of ideas. The brainstorming technique can be delimited by a specific situation, environment or context for example a specific market or necessity for which the group of experts and entrepreneurs must generate ideas, in this grounding of the brainstorming, some conditions forecasting can also trigger the generation of good ideas.

In some situations, the use of a matrix relating the necessities and characteristics of markets and the features covered by technology can be convenient (Table 5). In this matrix, the entrepreneur group can register and visualize potential product ideas by relating the technologies that they identified with an advanced mature level enough for commercialization and useful for developing markets, with those markets’ necessities listed in the previous task. The level of detail of the matrix depends upon the depth and extension of the information gathered.

As it can be seen in the matrix, the variables of this analysis are the functions of the technology (F1, F2, … FN; for each technology) and the markets needs (N1, N2, … NN;
for each needs´ classification) and the interaction between them, if the function in the row can solve or support the necessity in the correspondent column, then that information must be explicated in the cell in the intermediation. It is important to highlight that innovative technological products can be achieved by the combination of various techniques were there exist at least one new; but also by the combination in an original way of two or more known techniques or technologies.

From the ideas generated, the entrepreneur group can decide weather to evaluate all of them or to select the most promising according to their experience and the research done about the technology and the market.

According to Mahajan and Banga (2006), the lack of infrastructure in emerging economies can sometimes represent a green-field opportunity that allows entrepreneurs to find opportunities by “leapfrogging” forward to more advanced technological solutions. Successful cases of product commercialization in emerging economies (as defined in the literature review) have given as a result the following lessons for entrepreneurs:

- Take advantage of the rapid adoption of the technology in developing countries.
- Use next-generation technologies, this is to say that the cost-benefit equation for adopting a new technology in emerging or developing countries can be very different from that in the developed world, thus it is important not to discard new technologies until information is available to support the decision making process.
- Modify and apply existing technologies in new ways, and make advantage of the utilization of old skills of those emerging and developing markets in new ways.
- Create low-cost innovation that mimics other technologies that are used for satisfying correspondent necessities in more developed countries or markets.
- Develop community technologies, since in developing and emerging economies it is frequent the existence of many users sharing products, for example cell phones or access to the internet.

As the main output of this stage is just the product ideas catalog, the prioritization of the importance of the product idea or feasibility of it is not the scope, the feasibility evaluation and convenience of each product idea generated in this stage will be made in the next stage.
4.3.2. Selection and Prioritization of Ideas

The second stage consists on the selection and prioritization of the ideas generated in the first section. According to Jolly (1997), generating a list of potential applications is often not as complicated as deciding on which among these applications to pursue and when. The information gathering in this stage is more comprehensive than the research done in the previous section, since is in this part of the methodology where the feasibility evaluation and the potential determination for the technology commercialization is carried out. As mentioned before, this stage is placed on the Incubating sub process of Jolly’s process, with the aim of identify which products can be better commercialized in the market and giving enough information for the establishment of a business model as well as a business plan for successful penetration to the market.

With the meaning of obtaining an adequate performance of the venture, this stage is focused on providing enough information for the risk diminishing when selecting which project to start, when and under which considerations. The sub stages definition of this stage is strongly supported by the screening for attractive applications that was defined in the literature review as contribution of Jolly’s process to this thesis (Figure 13 from the literature review), as well as the considerations made by Kozmetsky and Kilcrease in 1994 (cited on Phillips, 1997) also introduced in the literature review. In order to have a more integrated approach for the definition of each product idea, the author considered in the three main axis of this stage (Market Attractiveness, Technical Feasibility and Commercializability) all the elements of the CATWOE Technique for soft systems definition proposed by Peter Checkland: Customers, Actors, Transformation Process, World View, Owner and Environment Constraints, in order to expand the thinking on the problem to solve by means of the product idea.

Figure 15 shows a depiction of the 4 sub stages that will provide all this information.
The first part of this screening consists in eliminating applications (or product ideas) that have little venture interest. This is then followed by evaluating the remaining ideas for their potential commercializability. Finally, for the prioritization of those applications, a method based on Analytical Hierarchy Process is proposed, nevertheless, as proposed by Jolly (1997), the actual weights to assign to individual criteria and how many applications to pursue, and in which sequence, depends on the entrepreneurs’ circumstances.

4.3.2.1. Market Attractiveness Assessment

For new ventures in general, applications of interest are those targeted to attractive markets, which exhibit high and stable growth rates and ones in which potential customers themselves are very profitable (Jolly, 1997). However when the attempt implies business opportunities in less developed (and subsequently more risky) markets, in emerging or developing economies, the attractiveness of the market must be those for which the product represents an essential need, and the size of the potential market is large enough to justify the investment.

The understanding of who is the receiving end of the product idea, the problem that they have for which the solution is intended, and how will they react to what the
entrepreneurs are proposing is the departing point for the determination of the market attractiveness.

The activities are proposed in Figure 19 as basis of the market attractiveness measurement. It is important to notice that usual elements for market analysis, such as price, channels, etc, are not included for the particularities of developing and emerging markets. It is important to remember that innovation in methods of payment, business models, and potential alliances is totally determining for the success of technological products entrance in low income markets: “Hewing to the factors constituting competitive position and market attractiveness has been shown to improve the chances of launching new products successfully” (Jolly, 1997).

![Figure 19. Market Attractiveness Assessment](image)

**Research and analysis of current situation of the market**

The first pillar of the market research and analysis is the current situation of the developing market; this is to identify the market size but more important its growth rate trends.

**Market size:** The size of the market can be evaluated based on potential sales if the use of the product was achieved. When attempting to commercialize new to market products, the quantity of potential customers that share the necessity for which the
product is intended can determine the market size. If the business opportunity was exploited successfully, the amount of customers will determine the market size. Sources of information for determining market share are government data, trade associations, and customer surveys.

The exploration of customer needs, perceptions and buying behavior can give an idea of how attractive can the market size be for entrepreneurs. The demand by time can also give significant information to the entrepreneurs about the size of the market, and it is important to know if the demand will be satisfied with only one purchase by the client, or the purchase will be repeated, also if there are potential products and services that the entrepreneur can offer by investing in the business opportunity. It is important to keep in mind that for developing economies and emerging economies, such as Mexico, products are expected to last long. For example, in rich economies, such as USA, houses are temporal goods, actually people change house from 5 to 6 times in their lifetime, while in Mexico people buy or build a house that is expected to last all their life and is expected to continue being useful for the next generations.

**Market Growth:** Market growth anticipation and expected market trend rates for products consumptions can be obtained by extrapolating historical data into the future, nevertheless the most efficient way to do so, is by studying the growth drivers such as demographic information and sales growth in complementary products. This is the understanding of the potential demand in the long-run offered by the product idea. Developing and emerging markets are experiencing important changes in political, economical and social issues, thus the understanding of this market dynamics is central for the identification of the market attractiveness.

*Identify the value to the market of the product idea*

The second pillar for the market attractiveness solidity for developing and emerging markets has to do with the product idea value perceived by the customers. The development of interviews to potential customers is a powerful tool for this purpose. The market became more attractive for investments when the product addresses a pending problem. The entrepreneur group must clearly recognize if there are a critical problem that could be solved by pursuing the business opportunity in the selected
market, this is to identify the “pain” addressed by the solution offered by means of the product idea, the currency of the problem for the market, as well as the identification and definition of the “innovative elements” of the product idea; all this information will determine the level of interest of potential customers.

The inexistence of a previous solution of the problem or necessity addressed by the product might enhance its market perceived value, it is important to notice if the beneficiaries of the final product or service are willing and able to pay, or if they can be easily funded (McGrath and MacMillan, 2000).

The value of the product for the market is also determined by its uniqueness and superiority, when the technology application is first to market it has the “early mover advantage”, contrary to the situation when there is a dominant competitor in the technological field in the market. This uniqueness of application can be the form of offering either the most cost-effective solution or a unique technical solution, because they often tend to be substitutes in a known product (Rahal and Rabelo, 2006). The group must recognize competing technologies or products that satisfy those necessities as well as the strengths and weaknesses of competing products.

**Determination of the impact of the new product’s entry**

The impact of the new product’s entry is the extent to which the project has the potential to bring wholly new benefits or significant leaps in known benefits to the market. The three main market axes that can be influenced by the product can be classified on social impact, economical impact and impact on the technological regime.

**Social Impact:** For example when the project solves a problem which has been poorly addressed at the time in the marketplace, or when the project offers to the market some benefits that were not possible before. The Maslow pyramid of needs determinates the benefits for people in different kinds of economies. People on developing and emerging economies have different needs than those in developed countries, usually poor people’s scarcities are related to the basic Maslow hierarchy, “they are often focusing on scratching out the most fundamental needs for food, clean water, refuge and a chance to earn a living to provide for those same needs” (Prahalad, 2004).
**Economical Impact:** Economical benefits can be measured by the potential products and services that can be fostered by the introduction of the project, in this concept is included the complementary products and services, suppliers of raw material, transportation services, also the potential competitors. For example, the innovative commercialization system of Hindustan Lever is based on a direct distribution network to hard to achieve locations; the enterprise selected a group of entrepreneur women that habited on those villages for the distribution of Hindustan products on those places. These women are called “Shakti Amma” (empowered mothers) and have been benefited by a commission for the sell of the products (Prahalad, 2004).

**Technological regime Impact:** Impact on the technological regime can be distinguished by the prospected life quality enrichment as a result of the scientific and technical progresses in the region. The entrepreneurs must anticipate if the project has the potential to set a new standard in the industry, that will foster the technical and scientific development in the marketplace, resulted both, of new technical/scientific value chain members that enters to the market, and the possible development triggered by research institutions and SMEs in the region.

**Environmental Impact:** In a global context, social, technological and economical development is strongly connected with societies foot print to the environment. Industrial activity has a big commitment with environmental concerns, is for that reason that entrepreneurs must evaluate the potential environmental issues resulted of the fabrication, utilization and disuse of the products and land use in order to consider politics of diminishing ambient damages. Many developing and emerging markets, share an excess of natural resources, for which the arbitrary exploitation of those no renewable gifts, jointed to the urban areas´ growth has determined a big impact of the human activities over the local, regional and global ecosystems. All this issues represents significant risks for the global environment since some of those economies are growing exponentially, such is the case of China that has been criticized due to its dependence on coil. “China’s problem has become the world’s problem. Sulfur dioxide and nitrogen oxides spewed by China’s coal-fired power plants fall as acid rain on Seoul, South Korea, and Tokyo. Much of the particulate pollution over Los Angeles originates in China, according to the Journal of Geophysical Research” (Kahn & Yardley, 2007).
The product idea must comprise in an acceptable level all the market attractiveness elements in order to be considered for the next sub-stages.

4.3.2.2. Technical Feasibility Assessment

Product ideas that passed the previous market attractiveness evaluation must be assessed by the intrinsic feasibility of the technology that is equally important. According to Jolly (1997), “easy applications both permit learning to occur in the marketplace and prevent technology-based ventures from turning into black holes, straining the patience of early bakers”.

The technical feasibility is the process of proving that the concept is technically possible, it tries to confirm that the product will perform as aimed, and that there are no preliminary production barriers. Technical feasibility concerns with questions such as whether the technology needed for the product is ready and available. Figure 20 shows the two main activities to be developed are represented as well as their inputs and outputs.

![Figure 20. Technical Feasibility Assessment](image-url)
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Evaluation of the Readiness of the Technology

Technology readiness determines which applications have to be taken first; this depends not only on the level of development of the technology and its location in its S-shaped curve but also in its readiness for the specific application.

**Development stage of the technology:** For each product, the group has to determine which the development stage of the technology is, when the production of one product would be ready (product & technology development time to market), the R&D necessary for the technology to reach the product development stage, the nature and sophistication of the technology (high or low), the technology’s degree of dependability (and compatibility) to other necessary technologies and the technology’s identifiable and quantifiable technological risks and weaknesses (Rahal and Rabelo, 2006).

**Technology Benefit-Costs:** In a global context, the cost issues of the technology are important, nevertheless sometimes in developed markets, the innovativeness of the product justifies a high price that customers are willing to pay. But the situation is different for developing and emerging economies, in which cost is a determinant factor for the acquisition of goods and services, this is why the considerations about the product’s competitive pricing, implementation costs, maintenance and decommission-related costs must be targeted when evaluating the technical feasibility.

All this has to be compared with the product’s significant benefits and advantages as perceived by the user when compared to current competing elements or products for needs satisfaction.

Evaluation of Technology Availability

The technology availability assessment must comprise the determination of the Intellectual Property rights, location of technological resources and human resources necessaries for the design and manufacturing of the product.

**Intellectual Property Openness:** The group must determinate if the technology and knowledge to be used in the product design, or manufacturing is protected. For this
purpose, a technology’s literature search must be completed, this search must comprise also a patents’ search and analysis, and it is preferably that the search is clean product, that the idea has no prior claims (Rahal and Rabelo, 2006). When there are some IP rights, it is important to measure the strength or exclusivity of intellectual property in order to take strategic decisions of how to proceed with the business opportunity (considering alliances, technology suppliers, etc.) when it worth it.

**Production Feasibility:** Another factor to analyze is the manufacture particularities, the group must evaluate the feasibility of producing the product considering if there is a preliminary idea for the production process design, assessing the knowledge about product or service’s design, performance, production requirements, and preliminary production costs.

**Resources Availability in Niche:** Sometimes, the existence of potential suppliers of complementary technologies in the market determines the success of a product commercialization in a particular market. The location of human resources is also important to judge, location of the skilled people, the ability and education level necessary for supporting the production, use and decommission of the product. Raw materials, tooling, energetic and natural resources must be evaluated in the potential production location.

### 4.3.2.3. Commercializability Factors Identification

This sub-stage has to do with the understanding of the factors that contributes to commercializability. The identification of the potential barrier or beneficial elements that could foster the market adoption of the product idea play a core role for the design of the business model that best utilizes all the features of the market and the technology for achieving market participation and customers acceptance.

The innovativeness of the product idea can comprise not only the product itself, but also the payment schema, distribution channels, collaborative models, etc. Once it has identified that the market is enough attractive for the entrepreneurs, and that they can have the technical potential to develop it, the way they must proceed to really have a
successful commercialization of the product idea should be done taking into account the inherent characteristics of the market and the technology. The main inputs and outputs of this activity are depicted in Figure 21.

**Figure 21. Commercializability Factors Identification**

*Identify factors to bring the product to the market*

The extent to which regulatory, competitive, value chain or customer reactions could prevent successful commercialization are the barriers that have to be analyzed in order to identify which factors are needed to bring the product to the market (Paulson et al, 2007).

According to Albrecht (1999) the exploration of the environment of the future enterprise has to address the following scope: a) customer; b) competitors; c) economy; d) technology; e) society; f) politics; g) regulations; and h) geophysics.

The author has comprised those fields in five principal elements that have to be studied when identifying potential barriers and factors necessaries for successful commercialization of products in developing and emerging markets (Table 7).
Table 7. Classification of potential barriers
(From Paulson et al, 2007 and Albrecht, 1999)

<table>
<thead>
<tr>
<th></th>
<th>Paulson et al, 2007</th>
<th>Albrecht, 1999</th>
</tr>
</thead>
<tbody>
<tr>
<td>Social Suitability</td>
<td>Customer reactions</td>
<td>Customer Field</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Society Field</td>
</tr>
<tr>
<td>Technological Convenience</td>
<td>Competitive</td>
<td>Competitors Field</td>
</tr>
<tr>
<td></td>
<td>Value chain</td>
<td>Technology Field</td>
</tr>
<tr>
<td>Economical Convenience</td>
<td></td>
<td>Economy Field</td>
</tr>
<tr>
<td>Political Convenience</td>
<td>Regulatory</td>
<td>Politics Field</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Regulations Field</td>
</tr>
<tr>
<td>Geophysical Aptness</td>
<td></td>
<td>Geophysics Field</td>
</tr>
</tbody>
</table>

**Social Suitability:** one of the most important barriers that can be faced by a product when attempting to target a specific developing and emerging economies, has to do with their customs, habits, values, identity, culture, believes, styles, preferences and life situations. This has to do not only with the demographic profile of the market but also the psychical characteristics of targeted consumers. The entrepreneurs must think in the context of the market guessing how they are reacting to changes in their ambient and identifying the level of acceptance of the product to be commercialized.

**Technical Convenience:** it concerns the analysis of the events, trends, and technical available solutions or in development that can be used by the entrepreneurs or against them for their effort of creating value to the customers. It is important to analyze the way people on the selected market has satisfied the necessity for which the entrepreneurship is going to focus its efforts, if there are competing products or industries. Identity, motives, strengths and weakness were analyzed in the previous stage, in this part, it is important to understand the potential conduct of other enterprises competing for the customers, and the way in which they can forbid or inhibit the entrance of a new product.

**Economical Convenience:** national economy in developing regions of the world and the international commerce situation can affect the buying behavior of the consumers, competing enterprises and the business opportunities.
Political Convenience: governmental processes, as well as the different power groups can affect the proceedings’ rules for making business in the developing or emerging market. Some of the factors to be taken into account is the possibility of the government to take part in particular industries (for example the cement industry expropriation made by the Venezuelan government), tributary policies, etc. Regulations’ understanding must be complete before deciding how to proceed, in order to avoid legal issues concerning environmental protection, employment laws, intellectual property, etc.

Geophysical Aptness: physical environment of the market includes the ecosystems and natural resources, but also the infrastructure of the region. Transportation and distribution particularities must be thought and planned before deciding whether the product idea is worth to be pursued or not, if it is possible to design a transportation or delivery system taking advantage of the human, natural and technical resources of the region.

Albrecht (1999) highlights that the real value of the analysis of all the elements of a market resides on the identification of interactions between all the elements explained. The importance of such analysis covers more strength in developing and emerging countries, since there are many social, political and economic obstacles to overcome in order to achieve the full potential that a new product could have, thus this analysis will serve for the identification of necessary complementary assets and capabilities that are needed or convenient in order to better take advantage of the market characteristics identified and featured in this stage.

4.3.2.4. Prioritization of product ideas according to its attractiveness and feasibility (technological feasibility and commercialization potential)

There exist many methods of evaluation of technologies in the literature, some methods are based on control lists, and some others are based on profitability indexes. For this methodology, it is proposed the use of the Analytical Hierarchy Process (AHP), which is a decision approach, designed to aid in the solution of complex multiple criteria problems.
in a number of application domains (Noorul Haq & Kannan, 2006). In Figure 22 it is depicted the inputs for this activity and the final output of the methodology.

The AHP technique was developed by Thomas L. Satty in the 1970s and is based on mathematics and human psychology since it attempts to mirror human decision process.

The AHP has been used in many fields the representation and quantification of the elements of a complex decision, the technique relates them to overall goals and evaluates alternative solutions. The AHP is proposed in this research in order to integrate a proved technique for prioritizing the product ideas generated in the first stage according to the tangible and intangible factors as perceived by the entrepreneurship group. The expected outcome of this stage is a prioritized ranking of each product idea alternative.
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If there is only one product idea to assess, the project group have to make the prioritization of the criteria presented in previous sections with the AHP technique, the ranking obtained will make easier the decision weather to produce it or not, taking into account all the factors in a fair manner. For example, if the product idea has a big market growth but there are many cost incurred with the manufacture of the potential product, the AHP technique will give a valuable tool for deciding which factor can be most important.

According to Jolly’s words (1997), if a single application meets all the three requirements (market attractiveness, technical feasibility and ease of commercialization), it is the best one to pursue.

The process proposed by Saaty (1990), adapted to this research can be summarized in the next steps:

**Step 1: Structuring hierarchies between criteria and alternatives**

The first step allows the design of the structure of the complex decision into a hierarchy descending from the overall objective to various attributes to sub-attributes, and so on until the lowest level. The overall objective or the fundamental goal for this research consists on the “Selection of the best product idea”. Table 8 shows the general and secondary criteria for the product idea prioritization and selection.

<table>
<thead>
<tr>
<th>General Criteria</th>
<th>Secondary Criteria</th>
</tr>
</thead>
<tbody>
<tr>
<td>Market Attractiveness (M)</td>
<td>Market Size (M1)</td>
</tr>
<tr>
<td></td>
<td>Market Growth (M2)</td>
</tr>
<tr>
<td></td>
<td>Value to Market (M3)</td>
</tr>
<tr>
<td></td>
<td>Social Impact (M4)</td>
</tr>
<tr>
<td></td>
<td>Economical Impact (M5)</td>
</tr>
<tr>
<td></td>
<td>Technological Impact Regime (M6)</td>
</tr>
<tr>
<td></td>
<td>Environmental Impact (M7)</td>
</tr>
</tbody>
</table>

According to Jolly’s words (1997), if a single application meets all the three requirements (market attractiveness, technical feasibility and ease of commercialization), it is the best one to pursue.
### Table 8. Criteria for the product idea prioritization and selection

<table>
<thead>
<tr>
<th>Technical Feasibility (T)</th>
<th>Development maturity stage (T1)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Technology Benefit-Cost (T2)</td>
</tr>
<tr>
<td></td>
<td>Intellectual Property Openness(T3)</td>
</tr>
<tr>
<td></td>
<td>Production Feasibility (T4)</td>
</tr>
<tr>
<td></td>
<td>Resources Availability in Niche (T5)</td>
</tr>
<tr>
<td>Commercializability (C)</td>
<td>Social Suitability (C1)</td>
</tr>
<tr>
<td></td>
<td>Technical Convenience (C2)</td>
</tr>
<tr>
<td></td>
<td>Economical Convenience (C3)</td>
</tr>
<tr>
<td></td>
<td>Political Convenience (C4)</td>
</tr>
<tr>
<td></td>
<td>Geophysical Aptness (C5)</td>
</tr>
</tbody>
</table>

In the last level of the hierarchy tree, the decision alternatives or “product idea” selection choices are depicted. It is important to highlight the fact that in the AHP technique all the product ideas are going to be connected to all criteria, and the hierarchy and prioritization corresponds to decision maker values, there is not an unique right answer, and the quantification of each element must be negotiated for the group. In Figure 23, the proposed AHP model is presented; it comprises the 4 levels for prioritizing and selecting the best product idea.

![Proposed AHP Model for Prioritization and Selection of Product Ideas](image)

*Figure 23. Proposed AHP Model for Prioritization and Selection of Product Ideas (Adapted from Noorul and Kannan, 2006)*
This hierarchy is proposed to be used for the assessment of all the product ideas generated in the first stage of the methodology, nevertheless, the entrepreneurs’ group should decide whether to include all the elements proposed in the previous sections, or selecting the elements that they consider significant for the analysis.

**Step 2: Setting Priorities through Comparative Judgements**

Once customized the hierarchy, the analytic hierarchy process is followed by establishing priorities among the elements of the hierarchy tree at each level. A set of comparison matrices of all elements in each level of the hierarchy with respect to an element of the immediately higher level are constructed, this is the relationship between two “secondary criteria” that share a common “general criteria” in the hierarchy so as to prioritize and convert individual comparative judgements into ratio scale measurement. In the same way, a last matrix including all the “general criteria” that are significant for the “goal”.

The use of matrices for pairwise comparisons helps to identify the consistency of the test, and allows a visual aid for obtaining additional information through making all the possible comparisons. Four general matrices are going to be used in this methodology: a 8 x 8 market acceptance matrix; a 5 x 5 technology feasibility matrix; a 5 x 5 commercializability matrix; and finally all of this “general criteria” will be compared in a 3 x 3 matrix. Table 9 shows the matrix for pairwise comparison between the “general criteria” according to its significance to the selection of the best product idea (goal) in the first levels of the hierarchy.

<table>
<thead>
<tr>
<th>Select the best product idea</th>
<th>M</th>
<th>T</th>
<th>C</th>
</tr>
</thead>
<tbody>
<tr>
<td>Market Attractiveness</td>
<td>M</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>Technical Feasibility</td>
<td>T</td>
<td></td>
<td>1</td>
</tr>
<tr>
<td>Commercializability</td>
<td>C</td>
<td></td>
<td>1</td>
</tr>
</tbody>
</table>

*Table 9. Matrix for pairwise comparison between "general criteria"*
Table 10 shows as example the matrix for the Technical Feasibility pairwise comparison in which all the elements (or secondary criteria) are compared according to their significance on the technological viability of the product idea.

<table>
<thead>
<tr>
<th>Technical Feasibility</th>
<th>T1</th>
<th>T2</th>
<th>T3</th>
<th>T4</th>
<th>T5</th>
</tr>
</thead>
<tbody>
<tr>
<td>Development maturity stage</td>
<td>T1</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Technology Benefit-Cost</td>
<td>T2</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Intellectual Property Openness</td>
<td>T3</td>
<td></td>
<td>1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Production Feasibility</td>
<td>T4</td>
<td></td>
<td></td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>Resources Availability in Niche</td>
<td>T5</td>
<td></td>
<td></td>
<td></td>
<td>1</td>
</tr>
</tbody>
</table>

*Table 10. Matrix for pairwise comparison for Technical Feasibility elements*

The first 4 matrices will give a prioritization of all the criteria according to the entrepreneurs’ experience and judgements. The selection and prioritization of the best product ideas is obtained with the same procedure, all the alternatives are compared between them under each secondary criteria (e.g. Table 11).

<table>
<thead>
<tr>
<th>Market Size</th>
<th>P1</th>
<th>P2</th>
<th>P3</th>
<th>P4</th>
<th>P5</th>
</tr>
</thead>
<tbody>
<tr>
<td>Product Idea 1</td>
<td>P1</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Product Idea 2</td>
<td>P2</td>
<td></td>
<td>1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Product Idea 3</td>
<td>P3</td>
<td></td>
<td></td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>Product Idea 4</td>
<td>P4</td>
<td></td>
<td></td>
<td></td>
<td>1</td>
</tr>
<tr>
<td>Product Idea 5</td>
<td>P5</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*Table 11. Matrix for pairwise comparison for Product Ideas according to the Market Size criteria*

The comparison between elements must ask two questions: a) which is more important with respect to the general criteria? And b) How strongly?

For example, element \( i \) is more/less/equal important than element \( j \). For each pair of secondary criteria, the decision makers must specify they preference in the form of a
fraction between 1/9 and 9. In Table 12 is shown the pairwise comparison scale proposed by Saaty (1990).

<table>
<thead>
<tr>
<th>Intensity of Importance</th>
<th>Definition</th>
<th>Explanation</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Equal importance</td>
<td>Two elements contribute equally to the property</td>
</tr>
<tr>
<td>3</td>
<td>Moderate importance of one</td>
<td>Experience and judgment slightly favor one element over another</td>
</tr>
<tr>
<td></td>
<td>over another</td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>Essential or strong</td>
<td>Experience and judgment strongly favor one element over another</td>
</tr>
<tr>
<td></td>
<td>importance</td>
<td></td>
</tr>
<tr>
<td>7</td>
<td>Very strong importance</td>
<td>An element is strongly favored and its dominance is demonstrated in practice</td>
</tr>
<tr>
<td>9</td>
<td>Extreme importance</td>
<td>The evidence favoring one element over another is of the highest possible order of affirmation</td>
</tr>
<tr>
<td>2, 4, 6, 8</td>
<td>Intermediate values</td>
<td>Compromise is needed between two adjacent judgements</td>
</tr>
<tr>
<td></td>
<td>between the two adjacent</td>
<td></td>
</tr>
<tr>
<td></td>
<td>judgements</td>
<td></td>
</tr>
<tr>
<td>Reciprocals</td>
<td>When activity $i$ is compared to $j$ is assigned on of the above numbers, then activity $j$ compared to $i$ is assigned its reciprocal.</td>
<td></td>
</tr>
</tbody>
</table>

**Table 12. Scale of preference between two elements (Saaty, 1990)**

As explained in Table 9, the pairwise comparison matrix has one position to enter the number (from 1 to 9) and another to enter its reciprocal, thus if one element does not contribute more than another, the other must contribute more than it. According to Satty (1990), an element on the left part of the matrix is by convention examined regarding its dominance over an element at the top of the matrix.

Each matrix requires $n(n-1)/2$ judgements, being $n$ the number of elements in each cluster analyzed. In the case of the general criteria matrix shown in Table 9, the number of judgements is $3(3-1)/2=3$. Note that 3 of the 9 cells to be filled correspond to 1s, the rest corresponds to the judgements and it’s reciprocal. In the same way, the calculus for
the other matrix was done: 28 judgements for the Market Acceptance matrix; 10 for the Technical Feasibility; and 10 for the Commercializability.

In this part, all the clusters’ elements in the hierarchy tree must be compared. When there are many people developing the set of matrices, the multiple judgments can be synthesized by using their geometric mean.

**Step 3: Calculus of priorities and test of consistency for each matrix**

In order to weight the vectors of priorities by the weights of the criteria, there are some commercial programs that can be helpful for computing all the information (e.g. Expert Choice, 2007). For this research, an excel file was programmed according to the calculation process described by Saaty (1990).

After all the matrices have been developed and all pair-wise comparisons are obtained, the next step is the calculation of the priorities in each matrix. The calculus of the priorities is possible by the normalization of the matrix and the calculus of a relative weight (see Figure 24).

**Figure 24. Calculus of the priorities for each matrix**
Chapter 4. Methodology

The first operation consist on the addition of all the judgements $J_{m,n}$ of each column, in the second matrix, the cell will be composed by a normalized value $N_{m,n}$ which is the ratio between the original value of the Judgment $J_{m,n}$ and the total of the correspondent column. The third operation consists of the addition of all normalized judgments of each row to obtain the priority of each criteria $C_m$.

In order to evaluate the consistency for the hierarchy, it is possible to obtain the values of an eigenvector $\lambda_{m_{\text{max}}}$. For obtaining the eigenvector $\lambda_{m_{\text{max}}}$, a third matrix is needed whose cells are going to be filled with the result of the multiplication of the original Judgment $J_{m,n}$ in each column and the obtained priority the correspondent criteria (operation 4 in Figure 25).

The eigenvector will be used for the calculus of the consistency ratio CR that will be compared with a random index RI from tables (obtained from a large number of simulation runs and varies depending upon the order of the matrix, see the values in Table 13).

Figure 25. Calculus of the $\lambda_{m_{\text{max}}}$ of each matrix

The value $\lambda_{m_{\text{max}}}$ is the addition of the vector lambda whose elements are calculated as the ratio of the addition of each row and the correspondent priority for the criteria in the row.
The calculus of the CI is as follows:

\[ CI = (\lambda_{\text{max}} - n) / (n - 1) \]

Where \( n \) is the number of elements compared in each matrix, this is the matrix level.

The acceptance of the CR, which is the ratio between the CI and the RI, varies according to the order of the matrix. For example for a 3 x 3 matrix, the acceptable CR value is 0.05; for a 4 x 4 matrix, 0.08; and for all larger matrices the acceptable CR value is 0.1 (Noorul Haq and Kannan, 2005).

When the CR is not acceptable for a matrix, the comparative judgements should be reviewed by the project group, because an acceptable consistency property helps to ensure decision-maker reliability in determining the priorities of the set of criteria proposed in this research.

**Step 3: Hierarchical synthesis of priorities**

In order to obtain the final prioritization of the product ideas, the hierarchical composition is used to weight the vectors of priorities by the weights of the criteria. And finally the sum of all the weighted priority entries corresponding to those in the next lower level and so on, until an overall priority vector is obtained.
CHAPTER 5. CASE STUDY

5.1. Introduction

The case study discussed in this chapter is a demonstration of the methodology presented before for the generation, evaluation and selection of technology-based ideas for emerging markets. As was mentioned in chapter 2, the research presented in this document was developed in parallel with two case studies carried out by the research chair “Rapid Product Realization for Emerging Markets” of the ITESM, campus Monterrey. The participation of the author in the two case studies has served as an important input for the methodology construction, since the experiences gained through the case study development has nourished and enriched the methodology, and has been useful also for the validation of the research in a real scenario. In the following sections, is presented the formalization of the idea generation and evaluation for the project “Sustainable Greenhouse for the Mexican Market”, which has been being developed since January, 2008 and has achieved its advanced design phase.

5.1.1. STAGE 1: Generation a Portfolio of Product Ideas

The author considers important to mention that the construction of this case study has been strongly supported by the coordinator of the project team, Angel Adolfo Valerio Velázquez.

5.1.1.1. Selection and Analysis of the Technological area for Development

In accordance with the ITESM vision for 2015, besides its contributions to the scientific community, one of the main aims of the research chair “Rapid Product Realization for Emerging Markets” is the exploitation of all the knowledge, techniques, methodologies, experiences, etc, in order to offer accessible alternatives for the satisfaction of Mexican market needs as a way to bring an important contribution to the Mexican development.
By developing case studies, the research chair tries to exploit the technological research and developments achieved by research groups of the ITESM in all the participating campus, in order to develop technology-based products and services for their transferring to Small and Medium Size enterprises, or for the generation of spin-offs to take advantage of the potential business opportunities.

*Selection of the participants for the project*

Multidisciplinary research teams were conformed in order to ideate, conceptualize, design, products and/or services based upon the technical and engineering experience achieved by their profiles and backgrounds. The research team for the development of this project is formed by two professors of the Monterrey campus, three post-graduate students and four under-graduate students. The team has identified also the potential support from other professors and researchers from the ITESM campus Monterrey, and Ciudad de Mexico.

*Competences identification*

A self-assessment procedure was enough for the identification of all the group competences. Since the beginning of the project, the personal and business interests of the group members were identified to be:

- Technology-based business offering Integral Technological Solutions
- Products or Services to foster the Sustainable Development by being:
  - Environmentally friendly
  - Economically Affordable
  - Socially Responsible
- Agribusiness, referring to the range of business encompassed by modern food production.

The technical background of the group members are listed in the Table 14, this information was gathered from the members’ curriculum vitae, according to both, their academic and research background and their professional experience.
| Energy                                      | • Formulation and Evaluation of Energy Projects  
|                                            | • Alternative Energy Sources:  
|                                            | • Solar Thermal Energy  
|                                            | • Solar Photovoltaic Energy  
|                                            | • Wind Power  
|                                            | • Low Temperature Geothermal Energy  
| Mechanical Design                          | • Computer Assisted Design  
|                                            | • Mechanics of Structures  
|                                            | • Vibrations and Mechanical Material Properties  
| Information Technologies                   | • Collaborative Networking Structures  
|                                            | • Automation of Manufacturing Systems  
|                                            | • Instrumentation and Control  
|                                            | • Knowledge Based Engineering Systems  
| Manufacturing Systems                       | • Concurrent Engineering  
|                                            | • Enterprise Integration Engineering  
|                                            | • Strategic Technology Management  
| Agronomy                                   | • Vegetal physiology  
|                                            | • Hormonal Regulation Physiology  
|                                            | • Genetic Fito-improving  
|                                            | • Vegetables growth  
|                                            | • Greenhouse growing  
| Biotechnology                              | • Microbial Decomposition Processes  

*Table 14 Technical background and expertise of group members*

The order of appearance of the competencies is presented according to the level of participation of group members who are more directly related with the potential business opportunity.
Chapter 5. Case Study

Selection of the technological area for the development of the project

From the Strategic National Observatory (Observatorio Estratégico Nacional) web site (OET, 2008), it was possible to identify the Technical Megatrends and the Opportunities and Technological Behaviors they produce that are related with the core Technical Competencies of the group. The three Technical Megatrends that fit the technical competences are 1) New Energetic Technologies (Table 15), 2) Agricultural Biotechnology (Table 16), and 3) Artificial Intelligence (Table 17).

<table>
<thead>
<tr>
<th>Megatrend: New Energetic Technologies</th>
</tr>
</thead>
<tbody>
<tr>
<td>Description: Alternative energies to fossil fuels: Aeolian, solar, biocombustibles, etc.</td>
</tr>
<tr>
<td>Opportunities:</td>
</tr>
<tr>
<td>• Development of small photovoltaic systems</td>
</tr>
<tr>
<td>• Design and Development of Small Aeolian Systems</td>
</tr>
<tr>
<td></td>
</tr>
</tbody>
</table>

Table 15 New Energetic Technologies Megatrend (OET, 2008)

<table>
<thead>
<tr>
<th>Megatrend: Agricultural Biotechnology</th>
</tr>
</thead>
<tbody>
<tr>
<td>Description: Multidisciplinary science that uses alive organisms and/or their components and/or metabolites to develop or to modify nutritional and botanical products to improve its utility and aplicability.</td>
</tr>
<tr>
<td>Opportunities and Technological Behavior:</td>
</tr>
<tr>
<td>• Organic Agriculture more and more is spread as a consumption option.</td>
</tr>
</tbody>
</table>

Table 16 Agricultural Biotechnology Megatrend (OET, 2008)
Chapter 5. Case Study

**Megatrend:** Artificial Intelligence

**Description:** Systems able to reason, to learn, to glide, to communicate, to perceive the environment, and to move and to manipulate objects.

<table>
<thead>
<tr>
<th>Opportunities:</th>
<th>Technological Behaviors:</th>
<th>Mexican Sectors in which it has Impact:</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Elaboration of Intelligent control systems for specific dominions</td>
<td>• The increasing use of the Internet brings more services based on web: E-Commerce</td>
<td>• Services of Investigation and Technological Development</td>
</tr>
<tr>
<td></td>
<td>• The control of devices by means of the thought will be common</td>
<td></td>
</tr>
</tbody>
</table>

*Table 17 Artificial Intelligence Megatrend (OET, 2008)*

According to the personal and business interests, the Megatrend selected for development area for the project is the one related with New Energetic Technologies Megatrend; nevertheless the other two will be taken into account in order to identify potential complementarities to Energetic Technologies.

**Collection of information about the technology**

From the OET, it is also possible to recognize the technologies that are going to have a biggest impact for Mexico in the future:

- Wind Energy Systems
- Solar Energy Systems

And the supportive technologies from the other megatrends, in which the team members have experience, are the following ones:

- Organic Greenhouses
- Intelligent Control Systems
- Internet (for Collaboration and Commerce)

Since, according to the United Department of Energy (2007), worldwide wind energy is the fastest growing renewable energy technology, between 2000 and 2006 wind energy generation worldwide quadrupled. Together with Photovoltaic panels, wind energy sector
is the fastest growing in United States, since in 2007 wind capacity installations grew 45% and solar Photovoltaic panels 40% from the previous year.

From the same source of information, it was also possible to get information regarding the technology functions and applications, since the Prospective team form the ITESM have developed a complete research for the identification of technical advances for potential business opportunities. Experts in each technological area developed a complete description of the technologies, the advances in its functionality and applications; they also made reference to the principal research and development groups in each area as well as a vast recompilation of important information sources.

Analysis and interpretation of information

Martija (2004) points out that Wind Energy can be located as in its Growth period (according to its S-Curve) since the wind energy produced during last 30 years has been growing in a spectacular rate, while Solar Energy can be considered still in its Infancy (or embryonic) period.

According to the ITESM’s experts, the branches of the technology with best potential for the Mexican market, taking into account the level of development, cost and technology regional development are the following ones:

<table>
<thead>
<tr>
<th>Technology</th>
<th>Branch</th>
<th>Function</th>
<th>Applications</th>
</tr>
</thead>
</table>
| Wind Energy Systems| Small Wind Turbines with different capacities | • Convert the power of the wind into **electricity** by means of vanes or helices that rotate a connected central axis, through a series of gears to an electronic generator. | • Water Pumping.  
• Electrical energy generation for domestic use  
• Electrical energy generation for industry (SMEs) |
|                    | Wind turbines of vertical axis   | • Convert the power of the wind into **electricity**, this turbines have the main rotor shaft arranged vertically | • Electrical energy generation for domestic use  
• Electrical energy generation for industry |
Chapter 5. Case Study

<table>
<thead>
<tr>
<th>Solar Energy Systems</th>
<th>Small Photovoltaic Systems</th>
<th>Photovoltaic silicon cells whose electrons are exited by the light photons producing an electrical current (photovoltaic effect).</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Solar Thermal Systems</td>
<td>Systems that take advantage of the sun thermal radiation band using materials with high absorptance to transform radiation into thermal energy.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Water Pumping, Electrical energy generation for transportation, light signalization, etc. Water heating, Air conditioning, Food preparation, Water distillation, Farming product drying</td>
</tr>
</tbody>
</table>

Table 18 Technology Functions and Applications

5.1.1.2. Selection and Analysis of an Emerging Market

Selection of an Emerging Market

According to the project group interests, the selected market for analysis is Mexico; this selection is reinforced by the information obtained from the information sources presented in Table 19.

<table>
<thead>
<tr>
<th>Information Source</th>
<th>Information</th>
</tr>
</thead>
<tbody>
<tr>
<td>Secretaría de Energía (2007)</td>
<td>Mexico has a big potential for energy renewable production:</td>
</tr>
<tr>
<td></td>
<td>• High isolation levels: average 5kWh/m2</td>
</tr>
<tr>
<td></td>
<td>• Zones with high wind intensities: 2,900MW</td>
</tr>
<tr>
<td>CONAE (2008)</td>
<td>• Mexican society and government are strongly interested on taking advantage from renewable energies.</td>
</tr>
<tr>
<td>Plan Nacional de Desarrollo (2007)</td>
<td>• Sustainable development is the central axis for public policies.</td>
</tr>
<tr>
<td></td>
<td>• In order to achieve a national growth with quality, it is necessary to create the conditions for a sustainable development.</td>
</tr>
<tr>
<td>Secretaría de Energía (2007)</td>
<td>• For 2012 at least 36 percent of the electric energy generated in Mexico must come from renewable sources.</td>
</tr>
</tbody>
</table>

Table 19 Information gathered about Emerging Market selection
It is important to note the convenience for the Mexican market of the use of Wind Energy and Solar Energy as alternative energy sources, since Mexican natural conditions are favorable for such technologies.

According to the competencies, expertise field and team interests, it was particularized the focus market as the Low Income Mexican Agricultural Market, since it is one of the Mexican less wealthy economic sectors (Table 20).

<table>
<thead>
<tr>
<th>Information Source</th>
<th>Information</th>
</tr>
</thead>
<tbody>
<tr>
<td>OECD (2007)</td>
<td>• Rural regions account for more than 80% of the land in Mexico and are home to up to 37 million people (36% of the Mexican population)</td>
</tr>
<tr>
<td>Plan Nacional de Desarrollo (2007)</td>
<td>• The rural sector in general, continues to be the less productive sector (just ¼ compared to industrial sector, and 1/5 compared to services sector). It is a federal objective to increase the human and patrimonial level of Mexicans living in the rural zones.</td>
</tr>
<tr>
<td>SNITT (2003)</td>
<td>• The participation of the agricultural sector in the Mexican total GIP throughout period 1980-2005 has been uniform. As of year 2000 it begins to have a slight increase contributing a 8% in the total GIP.</td>
</tr>
<tr>
<td>SNITT (2003)</td>
<td>• There is concern about the fact that low-income agricultural producers have not been benefited for the integration to the North-American market through the TLCAN.</td>
</tr>
</tbody>
</table>

**Table 20 Information gathered for the selection of the Agricultural Mexican Market**

Collection and Analysis of information about the market

In order to obtain all the pertinent information of market necessities, the selected secondary information sources are listed bellow:

• OECD: Organization for Economic Co-Operation and Development.
• FAO: Food and Agriculture Organization of the United Nations.
The information gathered in the research from secondary information sources was shared to the group by periodical group meetings. And the following is the list of needs and challenges presented by the Mexican agriculture, as consequence of the current Challenges presented by SNIT (2003):

<table>
<thead>
<tr>
<th>Challenges (SNIT, 2003)</th>
<th>Needs</th>
</tr>
</thead>
<tbody>
<tr>
<td>Global competition as a result of international agreements (TLCAN, NAFTA, etc).</td>
<td>Financial needs:</td>
</tr>
<tr>
<td>The system of land possession known as “Ejido” is integrated by productive units that are not viable economically.</td>
<td>• Access to credits.</td>
</tr>
<tr>
<td>Credits are expensive or inexistent as a result of a weak banking system.</td>
<td>• Access to community technologies for costs-sharing.</td>
</tr>
<tr>
<td>High production and commercialization costs.</td>
<td><strong>Production technologies:</strong></td>
</tr>
<tr>
<td>Weak transportation infrastructure.</td>
<td>• Methods and Techniques for production intensification.</td>
</tr>
<tr>
<td>Low education level.</td>
<td>• Technologies for products quality improvement.</td>
</tr>
<tr>
<td>Lack of market information.</td>
<td>• Products preservation.</td>
</tr>
<tr>
<td>Lack of irrigation and polluted water supply.</td>
<td><strong>Information and training:</strong></td>
</tr>
<tr>
<td></td>
<td>• Access to education and training.</td>
</tr>
<tr>
<td></td>
<td>• Access to trustworthy and opportune market information for decision taking.</td>
</tr>
<tr>
<td></td>
<td><strong>Infrastructure:</strong></td>
</tr>
<tr>
<td></td>
<td>• Adequate irrigation systems.</td>
</tr>
<tr>
<td></td>
<td>• Access to uncontaminated water.</td>
</tr>
<tr>
<td></td>
<td>• Electrification.</td>
</tr>
</tbody>
</table>

*Table 21 Mexican Agricultural Market Challenges and Needs*
5.1.1.3. **Link between technologies and the market**

<table>
<thead>
<tr>
<th>Access to Credits</th>
<th>Access to community technologies</th>
<th>Production Intensification</th>
<th>Products quality improvement</th>
<th>Production Preservation</th>
<th>Access to education and training</th>
<th>Access to market information</th>
<th>Irrigation Systems</th>
<th>Clean Water supply</th>
<th>Electrification</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Small Horizontal Axis Wind Turbine</strong></td>
<td>Electricity generation (1.5 kW)</td>
<td>These systems increase production support devices as drillers, dryers, etc.</td>
<td>Powering production improvement devices (e.g. heaters, CO2 fertilization devices, etc)</td>
<td>Powering refrigeration and conservation equipment (refrigerators, production preservation chambers, etc)</td>
<td>Powering tele-education systems</td>
<td>Powering communication systems</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Small Vertical Axis Wind Turbine</strong></td>
<td>Electricity generation (800 W)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Solar Photovoltaic System</strong></td>
<td>Electricity generation (small-medium and large scale) 70W-2MW</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Solar Thermal System</strong></td>
<td>Thermal energy generation (low, medium and high temperature) 40C-80C</td>
<td>These systems in medium to large scale can give support to rural communities</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Organic Greenhouses</strong></td>
<td>SAGARPA and CO NAE give credits for the owners of these systems</td>
<td>Greenhouses conditioning</td>
<td>Solar based refrigeration and drying systems</td>
<td>Powering tele-education systems</td>
<td>Powering communication systems</td>
<td>Powering water pumps</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Intelligent control Systems</strong></td>
<td></td>
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<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Internet</strong></td>
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<td></td>
<td></td>
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<td></td>
</tr>
</tbody>
</table>

*Table 22 Link between technologies and the market—Case Study*
Group sessions were made in order to generate some product ideas as a result of the experience of team members on the selected technical megatrends and the agricultural market, as well as the list of technology applications and market needs.

The identification of the relations between the technologies and the markets’ needs was made by grounding the exploration, looking for the way the technology in each row can satisfy or be related with each need in the correspondent column. Some ideas were excluded since they were considered by the group as expensive and with low-potential for the Mexican agricultural market.

By associating the ideas generated, the product ideas generated can be listed as follows:

- Low-cost, customized, energy efficient and low-emission greenhouse.
- Water pumping system based on a Small Horizontal Wind Turbine.
- Water pumping system based on a Small Vertical Wind Turbine.
- Water pumping system based on solar irradiation.
- Small energy generation using horizontal wind turbines for rural consumption.
- Small energy generation using vertical wind turbines for rural consumption.
- Small energy generation using solar photovoltaic panels for rural consumption.
- Passive solar temperature control for a greenhouse.
- Solar refrigeration chamber for production preserve.
- Agricultural E-Commerce System for Ejidos in which collaboration regarding best practices is allowed between different producers.

As it can be noticed from the alternatives generated in this step of the methodology, some of them are focused to the same need, but reached by means of different technologies, this is an important observation since it will simplify the evaluation of the ideas in the next stage.
5.1.2. STAGE 2: Selection and Prioritization of Ideas

The main purpose of this chapter is the demonstration of the methodology in a real case. In order to cope with such objective, and according to the time availability, the author has decided to carry out the assessment of only one product idea. As explained in chapter 4, when it has to be evaluated only one product idea, the AHP technique is used for the ranking of the criteria, and the entrepreneur group should take the decision weather to produce it or not by taking into account all the factors in a fair manner (according to its weight).

The product idea to be evaluated is the “Low-cost, customized, energy efficient and low-emission greenhouse”.

NOTE: An important part of the information contained in the market attractiveness assessment, as well as the commercializability assessment is contained in the document: “Greenorgan-E Business Plan” which has been presented by the team coordinator in the “Entrepreneurial Impact, International Summer School” in Munich, Germany at October, 2008 (Not Published).

5.1.2.1. Market Attractiveness Assessment

<table>
<thead>
<tr>
<th>Market Size</th>
</tr>
</thead>
<tbody>
<tr>
<td>• In Mexico, around 8 million people are working in the agricultural sector (which represents the 18% of the 44.71 millions of Mexican labor force). (CIA, 2007)</td>
</tr>
<tr>
<td>• At the moment, just 6% of the farmers can afford an efficient greenhouse which means that 94% of the farmers have to deal with the highly vulnerable and inefficient open field production.</td>
</tr>
<tr>
<td>• Mexico generates a GDP of US$ 893.4 billion dollars, 4% of that amount is created in agriculture. (CIA, 2007)</td>
</tr>
<tr>
<td>• In contrast to the low proportion of GDP produced in agriculture there is a high proportion of population working in this sector.</td>
</tr>
<tr>
<td>• The area actually covered by greenhouses in Mexico amounts to</td>
</tr>
</tbody>
</table>
7,856 sq km, which represents approx. 3% of farmland.

- Approximately 4 million people of the productive population in Mexico is involved directly in the agricultural sector, that means these are farmers, that are integrated in geographical unions named “Ejidos” (SRA, 2008).

- At the present 31,500 Ejidos are operating in Mexico, however, just 6% of these unions have an efficient greenhouse or an efficient production system and have direct contact with their clients, what makes them competitive. In contrast 76% of the Ejidos are small producer unions oriented to self-consumption and cannot afford the price of a common greenhouse, (SRA, 2008).

### Market Growth

- The demand for greenhouses in Mexico rose from 50ha in 1991 to 1000ha in 2001 and the forecast for the next years is also very promising (SAGAPRA, 2006).

### Value to the Market

- The agricultural sector is crucial to Mexico. It produces 4% of GDP, feeds around 110 million people and employs 18% of the workforce.

- In addition, the farmers have to fight against climatic injuries that have as result that just the 10% of the annual sow area could be grown and that greenhouses become an urgent necessity in the country (SAGARPA, 2006).

- A low-cost, customized, energy efficient and low-emission greenhouse, will allow agriculturists to produce organic products with the appropriate quality and quantity that is requested by the markets.

- Presently there are various reasons for Mexican producers to develop a greenhouse industry for vegetables (Cantliffe and Vansicke, 2003):
  - The need to reduce the impacts from variations in climatic conditions on production quality.
  - The opening of the Mexican economy accompanied with its access to different types of technology, ie people are willing to invest in Mexico.
Chapter 5. Case Study

- The search for solutions to different problems that affect open field production, for instance, various diseases, insects and weeds.

- An increase in demand by consumers for better and safer products (ie organic products), especially for export markets where food safety issues, including the border quality, have the potential to become major trade issues.

**Social Impact**

- The product would constitute a key piece for impulse the sustainable growth in Mexican rural sector since it gives Ejidos the possibility to offer local market organic products in a better quality and quantity. Ejidos could be able to deliver high quality products.

- Better conditions for low income farmers for exploiting their lands, will be traduced into more profits and thus better life level and life quality.

**Economical Impact**

- Producers who have land units of more than 5ha makes them more efficient with the use of technology of greenhouses, and they generate more profit than producers who are owners of short extensions of land (usually in the structure of Ejidos), who only can afford to cultivate grains and oleaginous (SNITT, 2003).

- A low cost customizable greenhouse would contribute to the economical development creating direct and indirect employments in Mexico, reducing poverty, migration and urbanization, supporting the technology development of the agricultural sector and so resulting in better living and production conditions for the farmers.

**Technological regime Impact**

- The current situation of the majority of the Ejidos in Mexico can be enormously benefited by the introduction of greenhouse technologies which would give an important competitive tool for agriculturists so that they can enter to better markets.

**Environmental Impact**

- Low emission greenhouses would reduce the CO2 emissions. These environmental benefits would be due to, the use of alternative energy sources and customized designs in greenhouses and a reduction of diesel consumption for e.g. for water supply.

*Table 23 Market Attractiveness-Case Study*
5.1.2.2. Technical Feasibility Assessment

| Development stage of the Technology | • Greenhouse technology is under constant development, the technology has been developed by some countries that have reached highly efficient and robust technologies for greenhouses.  
• The reduction of costs depends on the knowledge on the mean and long-term crop plant response to climate manipulation (Baille, 2001). Thus it is a necessary to develop:  
  - Models of how the crop response to environmental factors.  
  - Optimization methods that take into account the response of the crop, the cost of the equipment and greenhouse structure.  
  - Methods for customizing greenhouse design according to the environmental characteristics of the location. |
| Technology Benefit-Cost | • Greenhouse technological solutions are currently available but are often considered as too expensive by the growers.  
• “The huge opportunity arises from “optimization”, i.e. to find a consensus between the two extreme cases represented by the rudimentary shelters of mild-winter countries and the expensive high.tech glasshouses of North-Europe” (Baille, 2001)  
• Another big opportunity arises for the design of greenhouses using local equipments and materials. |
| Intellectual Property Openness | • Greenhouse technologies are based on ancient technologies, methods and processes, thus the Intellectual Property is not restricted for the “low technologies” needed for this product, since it will be resulted of “reverse engineering”. |
| Production Feasibility | • Greenhouses manufacture techniques are well known, many manuals for their instalation and construction are available in the litterature.  
• Labor force needed to construct and give maintainance to Greenhouses is available in Mexico. |
Table 24 Technical Feasibility-Case Study

5.1.2.3. Commercializability Factors Identification

<table>
<thead>
<tr>
<th>Social Suitability</th>
<th>People is interested on sustainable development of their regions.</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Organic agriculture is getting more and more strength in the consumers of this industry.</td>
</tr>
<tr>
<td></td>
<td><em>There is the feeling that the rural Mexican sector worries only for short term and obvious benefits.</em></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Technical Convenience</th>
<th>All the required technology is available and the members of the team are experts.</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>The technology is not very known in Mexico, and it can’t be easily learned by common engineers due specific knowledge in agro-science, electro-mechanic, physics, computer sciences and industrial engineering are required.</td>
</tr>
<tr>
<td></td>
<td>New technology is created, and this causes reduction off costs related with technology.</td>
</tr>
<tr>
<td></td>
<td><em>The technology used for low cost greenhouses changes very fast, and it will be necessary to implement a continuous education programme, in order to achieve that development velocity.</em></td>
</tr>
<tr>
<td></td>
<td><em>There exist many foreign companies that are specialized on greenhouses technology, nevertheless the solutions they offer are often too expensive and not customized to the Mexican market necessities.</em></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Economical Convenience</th>
<th>The fossil fuel cost used to power the traditional agricultural market systems (greenhouses and intermediate dealers) is raising and it is expected that the traditional energy cost rises too, shorten the investment pay-back time.</th>
</tr>
</thead>
</table>
|                        | The green and social-responsible costumers has an impressive...
annual growth all around the world and specifically in developing economies were the benefits of this lifestyle are obvious.

- This project has a social, environmental and economical nature, this concept has a huge support in the actuality and because that it is possible to find governmental, international organizations, non-governmental associations and no-profit associations support.

<table>
<thead>
<tr>
<th>Political Convenience</th>
<th>Due to subsidies of the Mexican government for greenhouse-building, also the majority of low income farmers will be able to purchase a Greenhouse.</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>- Alianza para el Campo – 25,000 USD per project.</td>
</tr>
<tr>
<td></td>
<td>- PROCAMPO – 116 USD per month that the project last.</td>
</tr>
<tr>
<td></td>
<td>- Inducción y Desarrollo Del Financiamiento al Medio Rural – 20,000 USD per project.</td>
</tr>
<tr>
<td></td>
<td>- Sustainable Development Found – 25,000 USD per project.</td>
</tr>
<tr>
<td></td>
<td>- SAGARPA, Fundación Produce, FIRCO, FOFAE, SEDESOL and SENER, the objective of these organizations is the social equality and the sustainable development of the rural communities.</td>
</tr>
</tbody>
</table>

- “The ejidos and the agricultural communities have all the ministry support (financial) to develop their competences using technology based production systems...” (Abelardo Escobar Prieto- Minister for Agricultural Reform – “Reforma Agraria”; SRA, 2008).
- “There are many international founds for more than thousand millions of poor farmers (in the world) to help them in order to achieve a sustainable development and assure a better way of life to their families...” (Jacques Diouf, UN president for Agriculture; Newsweek, 2008).

| Geophysical Aptness   | Electricity coverage in Mexico reaches 96% of its territory leaving approximately 5 million people without population is located in isolated areas where grid extension is not economically feasible. (Secretaria de Energia, 2006) |
- The lack of infrastructure in some Mexican rural regions represents an important opportunity for this product, since the idea is to reach a Greenhouse design fed by alternative energy sources (mainly aeolian, solar, and geothermal) for agricultural activities such as water pumping systems, production preservation chambers, temperature and illumination control, ventilation, etc.

Table 25 Commercializability Factors-Case Study

5.1.2.4. Prioritization of factors for the evaluation of the product idea

Step 1: Structuring hierarchies between criteria and alternatives

All the criteria proposed by the methodology were considered to be relevant for the assessment of the Water pumping system based on a Small Horizontal Wind Turbine. In Figure 26, the AHP model for this Case Study is depicted.
Step 2: Setting Priorities through Comparative Judgements

The establishment of priorities was made by the group in order to identify which factors are more relevant for the successful commercialization of low cost and low emission customizable greenhouses for the Ejidos in Mexico.

In the highest level of this comparison, the group gave a weight for each “general criteria” according to the success of the low cost and low emission customizable greenhouse for the Ejidos in Mexico; the comparison is showed in Table 26.

<table>
<thead>
<tr>
<th>Evaluation of the product idea</th>
<th>M</th>
<th>T</th>
<th>C</th>
</tr>
</thead>
<tbody>
<tr>
<td>Market Attractiveness</td>
<td>M</td>
<td>1</td>
<td>0.5</td>
</tr>
<tr>
<td>Technical Feasibility</td>
<td>T</td>
<td>2</td>
<td>1</td>
</tr>
<tr>
<td>Commercializability</td>
<td>C</td>
<td>0.5</td>
<td>0.5</td>
</tr>
</tbody>
</table>

*Table 26 Matrix for pairwise comparison between general criteria*

In the lowest level of the AHP hierarchy for this case, three matrixes were made in order to identify for each element (market attractiveness, technology feasibility and commercializability) what elements are the most significant in relation with the particular product idea addressed. (Table 27, Table 28 and Table 29).

<table>
<thead>
<tr>
<th>Market Attractiveness</th>
<th>M1</th>
<th>M2</th>
<th>M3</th>
<th>M4</th>
<th>M5</th>
<th>M6</th>
<th>M7</th>
</tr>
</thead>
<tbody>
<tr>
<td>Market Size</td>
<td>1</td>
<td>3</td>
<td>0.2</td>
<td>0.33</td>
<td>0.2</td>
<td>5</td>
<td>3</td>
</tr>
<tr>
<td>Market Growth</td>
<td>0.33</td>
<td>1</td>
<td>0.14</td>
<td>0.2</td>
<td>0.25</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>Value to Market</td>
<td>5</td>
<td>7</td>
<td>1</td>
<td>1</td>
<td>0.5</td>
<td>9</td>
<td>7</td>
</tr>
<tr>
<td>Social Impact</td>
<td>3</td>
<td>5</td>
<td>1</td>
<td>1</td>
<td>3</td>
<td>9</td>
<td>9</td>
</tr>
<tr>
<td>Economical Impact</td>
<td>5</td>
<td>4</td>
<td>2</td>
<td>0.33</td>
<td>1</td>
<td>7</td>
<td>8</td>
</tr>
<tr>
<td>Technological Impact</td>
<td>0.2</td>
<td>0.33</td>
<td>0.11</td>
<td>0.11</td>
<td>0.14</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Environmental Impact</td>
<td>0.33</td>
<td>0.33</td>
<td>0.14</td>
<td>0.11</td>
<td>0.13</td>
<td>1</td>
<td>1</td>
</tr>
</tbody>
</table>

*Table 27 Matrix for pairwise comparison between Market Attractiveness factors*

<table>
<thead>
<tr>
<th>Technical Feasibility</th>
<th>T1</th>
<th>T2</th>
<th>T3</th>
<th>T4</th>
<th>T5</th>
</tr>
</thead>
<tbody>
<tr>
<td>Development maturity stage</td>
<td>T1</td>
<td>1</td>
<td>1</td>
<td>5</td>
<td>3</td>
</tr>
<tr>
<td>Technology Costs</td>
<td>T2</td>
<td>1</td>
<td>1</td>
<td>3</td>
<td>1</td>
</tr>
<tr>
<td>Intellectual Property</td>
<td>T3</td>
<td>0.2</td>
<td>0.33</td>
<td>1</td>
<td>0.33</td>
</tr>
<tr>
<td>Production Issues</td>
<td>T4</td>
<td>0.33</td>
<td>1</td>
<td>3</td>
<td>1</td>
</tr>
<tr>
<td>Resources available in niche</td>
<td>T5</td>
<td>1</td>
<td>0.33</td>
<td>3</td>
<td>1</td>
</tr>
</tbody>
</table>

*Table 28 Matrix for pairwise comparison between Technical Feasibility factors*
Table 29 Matrix for pairwise comparison between Commercializability factors

<table>
<thead>
<tr>
<th></th>
<th>C1</th>
<th>C2</th>
<th>C3</th>
<th>C4</th>
<th>C5</th>
</tr>
</thead>
<tbody>
<tr>
<td>Social Suitability</td>
<td>C1</td>
<td>1</td>
<td>3</td>
<td>0.33</td>
<td>1</td>
</tr>
<tr>
<td>Technical Convenience</td>
<td>C2</td>
<td>0.33</td>
<td>1</td>
<td>0.33</td>
<td>0.33</td>
</tr>
<tr>
<td>Economical Convenience</td>
<td>C3</td>
<td>3</td>
<td>3</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Political Convenience</td>
<td>C4</td>
<td>1</td>
<td>3</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Geophysical Aptness</td>
<td>C5</td>
<td>2</td>
<td>5</td>
<td>2</td>
<td>1</td>
</tr>
</tbody>
</table>

It has to be noticed that for the comparison between all the factors, the idea of the low income and low emissions greenhouse was held on the mind of the group team. Each two-element contrast made answered the questions: Which one of this factors is more important for a successful introduction to the Ejidos’ market (respect to the correspondent superior criteria) for a low cost and low emission customizable greenhouse? How strongly?

Step 3: Calculus of priorities and test of consistency for each matrix

A sketch for AHP calculus was programmed in an Excel worksheet (see ANNEX 2 AHP –Excel Worksheet). For each matrix the analysis of congruence was done in order to assure the reliability of all the judgements of the group regarding their preferences. Figure 27 shows the results for the comparison between the general criteria: Market Attractiveness, Technical Feasibility and Commercializability.

![Product Success](image)

Figure 27 Priorities of General Criteria

The results shown in the figure resulted coherent with the general feelings of the team. Technical feasibility is the most significant criteria for the success introduction of
greenhouses technologies to Ejidos in Mexico, since the cost incurred with the technology, the level of understanding of the technology by the group and the availability of the technologies plays the most important role for the success of the business opportunity in the selected emerging market. Commercializability factors are the less important since the barriers they could represent can be tackled by innovative strategies, if the market is attractive enough and the technology is available and pertinent.

Figure 28 shows the results for the market attractiveness factors comparison. The most significant factors are Social Impact, Value to Market, Economical Impact and Market Growth.

![Market Attractiveness](image)

**Figure 28 Priorities of Market Attractiveness Factors**

It is not difficult to deduce that the importance of the social impact and the value to market resides on the nature of the project, since it is focused to the trigger of sustainable development for the Mexican agricultural sector, and one of the main competitive advantage of a “low income and low emissions customizable greenhouse” is it social focus. Thus it would be important to look for complementary strategies to reinforce the social impact of this product in potency, in order to take better advantage of its market attractiveness.

The priorities of technical feasibility factors can be seen in Figure 29.
For this criterion, it was noticed that the development maturity stage plays the most relevant role for the technical feasibility of the project, since to consideration of the team; the maturity of a technology influences its related costs as well as its intellectual property openness. For the case of low cost and customizable greenhouses the availability of resources in niche is also highly important since the literature reports many cases in which regional materials were used to produce greenhouses and this clearly reduced in the cost related with its installation and maintenance.

Figure 29 Priorities of Technical Feasibility Factors

Figure 30 Priorities of Commercializability Factors
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Regarding the commercializability factors, Figure 30 shows their weights. It was interesting to discover that according to the team’s opinion, geophysical aptness is the most important element for the commercializability of greenhouses’ technologies, since they agree that the infrastructure shortages represent key opportunity for the introduction and acceptance of greenhouses that integrates in their design the solutions to water supply, energy generation, etc.

Step 3: Hierarchical synthesis of priorities

Annex 2 shows the Excel worksheet in which the calculations for the hierarchical synthesis of priorities was done. The results of such calculations are shown in Figure 31.

![Evaluation of the Product Idea](image)

**Figure 31 Hierarchical synthesis of priorities**

The information obtained by the AHP technique was used by the team to decide whether to keep focusing their efforts to the design of the “low cost and low emission customizable greenhouse” as it was conceived, to modify the product concept or to discard it. It is also useful for identifying strategies to be pursued in order to best take
advantage of the business opportunity, and to evaluate if the focus market is ready to accept the product.

5.1.2.5. Case Study Results

The project of designing a low cost greenhouse for the Mexican Ejido was started since summer 2008. Valerio et al (2008c) presented a first design and material selection for the structure of the greenhouse named SUGREMEMA-Pro for the northeast Mexican market. Figure 32 shows the final design of the greenhouse structure in the frame of the Methodology for Rapid Product Realization (Molina, et al 2007).

![Figure 32 Green house structure (Valerio et al, 2008)](image)

Five materials were tested by a finite element computer aided test test (COSMOS\textsuperscript{TM}-SolidWorks\textsuperscript{TM}); and a techno-economic analysis was developed in order to achieving both: an optimal design with minimal costs. The best material for the selected design (SUGREMEMA-Pro Tunnel) was the Steel SAE-1035. It was interesting to find that the
bamboo sticks are a good option, but its security factor is very low Valerio et al (2008c) (Figure 33).

In October, 2008 a business plan for a low cost greenhouse for the Ejido was presented by Angel Valerio in the Four 4 Entrepreneurship summer school at Munich, Germany under the name Greenorgan-E (see Figure 34). The business plan integrates all the information presented in this case study in a business model that promises to offer a unique investment opportunity for growth, with a return potential of about 20% p.a., with CO2 emissions savings of 25tons per year per unit, energy savings of 22,000 Euros per 10 years of operation, and promises also to represent an important opportunity to foster societal changes in/and through the agricultural sector in Mexico.
Comments from experts and investors regarding the success potential of the project were highly encouraging.

5.1.2.6. Case Study Conclusions

- The idea of a low cost greenhouse for the Mexican Ejido is worth to be pursued, since greenhouse technology is mature and proved enough for its commercialization. Reverse engineering processes can be used for the design of a greenhouse that could cover the specific necessities of the low income Mexican market.
- The most important factor for the success of this project is the utilization or implementation of mature greenhouse technologies in order to reduce the technology costs, since Ejidos could not afford expensive technologies even if the payback of the technology was favorable.
In terms of sustainability, the most important impact that could be accomplished by this project is the social impact (by increasing the life quality level of rural families), nevertheless the economical benefit of the population is a secondary effect once the Ejidos’ farmers can get access to a new and more rentable market.

The Ejido market in Mexico is located all over the country, and there is a large diversity between the natural conditions (weather, humidity, ecosystems, etc) in Mexico, thus the “customizability” of greenhouses would represent an important competitive advantage for a new venture.

It is important to search for regional materials and evaluate them in order to identify if they can be used for a better design for greenhouses at each location.

The value to the market of the product is high and the governmental support in the form of regulations, subsidies, etc., can benefit this project.

Environmental issues are not the main concern of potential customers, nevertheless in order to get support from governmental subsidies,

It is of little importance to introduce “high greenhouse technology” to the low income agricultural sector in Mexico, since this factor resulted to be the less relevant one of the analysis.
RESULTS, CONCLUSIONS AND FUTURE WORK

Results discussion

The development of a methodology for technology-based products for emerging markets was done in this thesis. The general and particular objectives described in Chapter 1 were fully achieved; a methodology for the ideation of technology-based products or services for emerging markets has been presented. This methodology was planned for providing entrepreneurs a tool for the identification of business opportunities in less-developed markets. In function to the objectives presented in chapter 1, the results achieved by this research work are discussed below:

- This effort was set off with a general literature review in order to identify existent product conceptualization methods, innovation techniques, creativity tools, as well as information regarding technology-based products design and commercialization to less-developed economies. There was not evidence of a methodology for a similar purpose; nevertheless, some of these techniques, tools, methods and the knowledge and understanding gained serve as the basis for the research achievement.
- A methodology for the ideation of technology based products for specific emerging markets has been presented. This methodology comprises not only the idea generation process, but also the prioritization (or evaluation) process in order to assure the successful commercialization of the product.
- From end to end, this methodology was planned for satisfying necessities of less developed markets. This was achieved in the methodology by including a continuous monitoring of the market characteristics, behavior, needs, etc. Market conditions are taken into account since the generation of the idea until the evaluation (or prioritization) of the product ideas, all the information gathered from this monitoring, can be used by designers and entrepreneurs in order to integrate those important factors to the product and the business model to facilitate the acceptance of the product and the success of the new venture.
- This methodology gives attention not only to the market needs but also to the technological development, and links them in order to present business opportunities
to entrepreneurs interested on making profit by enhancing the technological development of emerging regions.

- This methodology integrates in all the steps information regarding emerging markets and some considerations and recommendations proposed by selected literature and the experience of the author for designing and commercializing products in emergent and developing markets.

- The methodology is strongly focused on the collection, analysis and interpretation of information regarding the technology that will be used in the product, and the market in which the product intends to be commercialized. Since the beginning of the methodology the project group gains important information about technical issues as well as market and commercialization factors that can be useful for the product design.

- Two case studies were developed in parallel with this research; one of them was presented in chapter 5. This case study has served not only to demonstrate the methodology, but it also supplied this research with empirical experience.

Conclusions

- All the objectives stated at the beginning of the research were achieved and are presented in this thesis document.

- The methodology is highly reliable since it is strongly supported by a broad literature review and empirical experience. Through all the methodology the tools, comments, and suggestions are adequately referenced.

- The mediation between the two main innovation approaches: market pull and technology push was achieved since the methodology initiates from the selection of the technological area for development and is strongly alert of the market potential of the technological application. The outputs of the methodology are a convergence between the technical environment and the real market identification.

- In order to delimit the scope of the creative process of product idea generation, and also in order to really achieve a feasible product idea, it was recognized the importance of the identification of the technical competences and personal interests of the group members.
CONCLUSIONS

- The structure of the methodology is easy to follow by entrepreneurs and research teams users of the methodology, since it explains adequately each activity, tool and resource needed for accomplishing each outcome.
- The methodology can be applied to all kind of technologies, since it has been configured in a general way, allowing for entrepreneurs with diverse technical background to shape a business opportunity.
- The methodology demonstrates to be consistent and unbiased since, even when the case study was developed by a group of engineers interested on high technologies and environmentally friendly solutions, the prioritization of all the factors considered in the methodology give as result that the technological impact and the environmental impact are the less important for the successful commercialization of low-income, and low emission greenhouses.
- The comments about developing and emerging markets presented through the methodology phases, catalyzes the generation of good ideas of products for those particular markets.

Future Work

The objective of the thesis was achieved in time and shape: a methodology for the construction of technology-based product ideas for emerging markets. Some recommendations of future research that could complement this work are listed bellow:

- Preparation of reference material for assisting the collection and analysis of information: questionnaires, formats and databases for the recollection of information regarding technological trends and market needs.
- Further research could be valuable regarding the prioritization of all the elements that should be considered for the success of technology-based products in the Mexican market as well as in other developing and emerging markets. Since this methodology relies on the opinion of each project group, a further research could address the general prioritization of the elements proposed in this thesis based on logical reasoning or historical behaviors, this could represent a strong help for entrepreneurs’ decision taking.
• More case studies should be carried out in order to validate and strengthen the methodology, by different teams with diverse starting points (technical background and business interests) and focused to different markets.
• The outcomes of all the methodology process can be integrated as inputs to the later stages of product realization process.
• Methodologies for the characterization of regions in terms of social, technological, political and economical needs and barriers would be an interesting research focus.
• Methodologies or methods for technological prospective in developing and emerging markets are also an interesting research focus.
• For the case study, it is recommended to evaluate in a similar way to the evaluation of the “low income and low emissions customizable greenhouse” the other product idea generated, since they could represent interesting business opportunities. It would be also convenient in order to identify which of them are the best options to include in the greenhouse design to offer an integrated solution to the Ejidos market, as well as to evaluate which of those business opportunities worth to be pursued first, and to rationalize the resources for each potential product realization project.
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ANNEXES

ANNEX 1  Summary of the Methodology

In this section the processes of each stage of the methodology are presented in the form of tables summarizing the main objectives, resources, inputs, activities and outputs for each stage and process of the methodology for conceptualization of products for emerging markets.

Stage 1. Generation of a Portfolio of Product Ideas

Objective: To generate a set of unique technology-based ideas linked to an emerging market’s needs.

Processes:

- Identification and Analysis of the Technological area for Development
- Selection and Analysis of an Emerging Market
- Link between technologies and the market
### PROCESS 1.1 Identification and Analysis of the Technological area for Development

**OBJECTIVE**
To select and analyze the technological area in which the innovation will take place

**RESOURCES**
- Primary Information Sources: Organizational Contacts, Meetings with experts, Consultancy, etc.
- Secondary Information Sources: Electronic and printed official documents, Technical and Business Literature, Perspective Data Bases (e.g. oet.itesm.mx from ITESM), search motors.

**TOOLS/TECHNIQUES**
- Interview
- Context Data Analysis, List Sorting, Charting/Mapping, Technology Forecasting
- Patents’ analysis and Scienciometrics

<table>
<thead>
<tr>
<th>INPUTS</th>
<th>ACTIVITIES</th>
<th>OUTPUTS</th>
</tr>
</thead>
</table>
| Selection of the participants for the project. | Participants of the project:  
- Entrepreneurs  
- Support Organizations (support institutions, research centers, technical associations, consultant enterprises, etc…). | Catalog of core aggregated technical competencies:  
- Personal and business interests: compromises, type of business intended, and ultimate goals of the entrepreneurs.  
- Technical background: issues related with entrepreneurs’ education and work experience. |

Participants of the project  
- Entrepreneurs  
- Support Organizations (institutions, research centers, technical associations, consultant enterprises, etc…).
<table>
<thead>
<tr>
<th>Catalog of core aggregated technical competencies:</th>
<th>Selection of the technological area for the development of the project.</th>
<th>Technological area selected (Trend)</th>
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<tr>
<td>• Personal and business interests: compromises, type of business intended, and ultimate goals of the entrepreneurs.</td>
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<td>• Technical background: issues related with entrepreneurs’ education and work experience.</td>
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<table>
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<tr>
<th>Data from information sources, such as:</th>
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<tr>
<td>• Megatrends</td>
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<td>• Technology business information</td>
</tr>
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<td>• Prospective</td>
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<td>• Technology Maps</td>
</tr>
<tr>
<td>• Technology Trends</td>
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<td>• Technology News</td>
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<tr>
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<td>• Technology Trends</td>
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<td>• Technology Features</td>
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<td>• Technology’s Description of Functionalities</td>
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<td>• Technology business information</td>
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</tr>
<tr>
<td>• Technology Maps</td>
<td></td>
<td>Technology Proved and New Applications</td>
</tr>
<tr>
<td>• Technology News</td>
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</table>
## PROCESS 1.2 Selection and Analysis of an Emerging Market

### OBJECTIVE
To select and analyze the market for which the product ideation will be directed.

### RESOURCES
- Primary Information Sources: Experts from research centers, local authorities, population.
- Secondary Information Sources: Published reports (printed and electronically) by periodical national and international reports in the selected area; specialized data bases of emerging markets.

### TOOLS/TECHNIQUES
- Context Data Analysis
- List Sorting
- Charting/Mapping
- Social Forecasting
- Affinity diagrams

### INPUTS

### ACTIVITIES

### OUTPUTS

<table>
<thead>
<tr>
<th>INPUTS</th>
<th>ACTIVITIES</th>
<th>OUTPUTS</th>
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</thead>
</table>
| • Technological area for Development Group Interests:  
- Project group interests and scope.  
- Natural conditions and features of the technological area selected.  
- Technological development of the subject in regions. | Selection of an emerging market. | Emerging or developing region selected. |
| Data from Information Sources:  
- Regional offices and authorities  
- Governmental reports (e.g. demography)  
- National and regional reports from NGO’s | Collection of information about the market. | Information selected and organized:  
- News  
- Statistics  
- Trends  
- Development plans |
| Information selected and organized:  
- News  
- Statistics  
- Trends  
Development plans | Analysis and interpretation of information. | • Catalog of needs of the market (current and future) according to infrastructure, education, health, public services, etc. |
<table>
<thead>
<tr>
<th>ANNEXES</th>
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<tr>
<td>• Needs prioritized according to social trends.</td>
<td>• Database of information about the market.</td>
<td>• Inventory and classification of the market’s needs.</td>
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<tr>
<td>• Database of information about the market.</td>
<td>• Understanding of the market’s needs, culture, wishes, habits,</td>
<td>• Essential understanding of the market’s needs, culture, wishes,</td>
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<tr>
<td>• Inventory and classification of the market’s needs.</td>
<td>values and customs</td>
<td>habits, values and customs</td>
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<td>• Essential understanding of the market’s needs, culture, wishes,</td>
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<td>habits, values and customs</td>
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</table>

**COMMENTS**

Patterns of change to monitor in emerging markets:
- Political and economic turbulence
- Strains on fragile infrastructure and environmental changes
- Youthful necessities and requirements
- Migration patterns into the cities
- Recognizance of opportunities for education
- Understanding of the changing roles of the women
### PROCESS 1.3 Link between technologies and the market

**OBJECTIVE**
To generate ideas of potential products and services that links the technology functions to the markets’ needs.

**TOOLS/TECHNIQUES**
- Brainstorm
- Nominal Group Technique (NGT)
- Grounding the Exploration

<table>
<thead>
<tr>
<th>INPUTS</th>
<th>ACTIVITIES</th>
<th>OUTPUTS</th>
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</thead>
</table>
| Analysis and Understanding of:  
  - Technology maps  
  - Technology mature functions  
  - Technology new and proved applications  
  - Classified current and future potential needs | Generation of product ideas | Catalog of product ideas linking technology functions to market needs |

**COMMENTS**
Lessons learned from product and services commercialization in Emerging Markets:
- Take advantage of the rapid adoption of the technology in developing countries
- Use next-generation technologies
- Modify and apply existing technologies in new ways
- Create low-cost innovation that mimics other technologies
- Develop community technologies
Stage 2. Selection and Prioritization of Ideas

**Objective:** To identify which products can be better commercialized in the market and to give enough information for the establishment of a business model as well as a business plan for successful penetration to the market

**Processes:**
- Evaluation of market attractiveness
- Evaluation of technical feasibility
- Identification of commercializability factors
- Prioritization of product ideas according to its attractiveness and feasibility
### PROCESS 2.1 Evaluation of market attractiveness

#### OBJECTIVE
To evaluate how attractive is the market for the entrepreneurs, for eliminating applications (or product ideas) that have little venture interest.

#### RESOURCES
- Primary Information Sources: Experts from research centers, local authorities, customer surveys.
- Secondary Information Sources: Published reports (printed and electronically) by periodical national and international reports in the selected area; specialized data bases of emerging markets, newspapers, etc.

#### INPUTS

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<td>Market Size identified (according to customer needs, perceptions and buying behavior)</td>
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<td>Government data</td>
<td>Growth Rate trends understood (by the understanding of drivers of growth)</td>
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<td>Trade associations data</td>
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<tr>
<td>Data collected from customer surveys.</td>
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<tr>
<td>Data collected from interviews with experts and potential customer</td>
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<tr>
<td>Information concerning demographic issues</td>
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<tr>
<td>Information of sales growth in complementary products</td>
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<tr>
<td>Research and analysis of current situation of the market</td>
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<tr>
<td>Identification of the value to the market of the product idea</td>
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<tr>
<td>Determination of the impact of the new product’s entry</td>
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<tr>
<td>Economical Impact identified and assessed</td>
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<tr>
<td>Environmental Impact identified and assessed</td>
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</tbody>
</table>

#### COMMENTS
- Developing and emerging markets are experiencing important changes in political, economical, technological, environmental and social issues, thus the understanding of this market dynamics is central for the identification of the market attractiveness.
- Methods of payment, business models, and potential alliances are totally determining for the success of technological products entrance in low income markets.
## PROCESS 2.2 Evaluation of Technical Feasibility

### OBJECTIVE
To prove if the concept is technically possible, to confirm if the product will perform as aimed, and if there are preliminary production barriers.

### RESOURCES
- Primary Information Sources: Organizational Contacts, Meetings with experts, Consultancy, etc.
- Secondary Information Sources: Technical and Business Literature, patents, manuals, etc.

### INPUTS
- Product Idea

  Information from primary and secondary sources:
  - Trade associations data
  - Technical reports for the description and characterization of the technological product idea
  - Data collected from potential suppliers
  - Data collected from interviews with experts

### ACTIVITIES
- Evaluation of the readiness of the technology for its application
- Evaluation of the availability of the Technology

### OUTPUTS
- Development maturity stage of the technology identification: measure of degree of dependability to other necessary technologies and Identification and quantification of technology’s risks and weaknesses
- Incurred technology-costs detection
- Measure of the strength or exclusivity of intellectual property
- Manufacture particularities (product or service design, performance, production requirements, and preliminary production costs)
- Availability of resources availability in niche (human and technical)
### PROCESS 2.3 Identification of commercializability factors

#### OBJECTIVE
To understand the factors that contribute to commercializability by identifying the potential barriers and beneficial factors that could foster the market adoption of the product idea, which is important for the design of the business model that best utilizes all the features of the market and the technology for achieving market participation and customers acceptance.

#### RESOURCES
- **Primary Information Sources:** Experts from research centers, local authorities.
- **Secondary Information Sources:** Published reports (printed and electronically) by periodical national and international reports in the selected area; specialized data bases of emerging markets, newspapers, etc.

#### INPUTS
- Product Idea
- Information from primary and secondary sources:
  - Government data
  - Trade associations data
  - Data collected from customer surveys.
  - Data collected from interviews with experts and potential customer
  - Information concerning demographic issues
  - Information of sales growth in complementary products

#### ACTIVITIES
Identification factors to bring the product to the market

#### OUTPUTS
- Social factors (customs, habits, values, identity, culture, believes, styles, preferences and life situations)
- Technological factors (analysis of the events, trends, and technical available solutions or in development)
- Economical factors (national economy)
- Political factors (governmental processes, power groups, regulations)
- Geophysical factors (ecosystems and natural resources, infrastructure)
- Interactions between factors recognized

#### COMMENTS
- The innovativeness of the product idea can comprise not only the product itself, but also the payment schema, distribution channels, collaborative models,
- The real value of the analysis of all the elements of a market resides on the identification of interactions between all the elements explained.
- This analysis will serve for the identification of necessary complementary assets and capabilities that are needed or convenient in order to better take advantage of the market characteristics identified and featured in this stage.
## Process 2.4: Prioritization of product ideas according to its attractiveness and feasibility

### Objective
To prioritize the product ideas generated in the first stage according to the tangible and intangible factors as perceived by the entrepreneurship group, by a representation and quantification of the elements of such a complex decision.

### Tools/Techniques
Analytical Hierarchy Process

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<th>Inputs</th>
<th>Activities</th>
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<td>Market attractiveness:</td>
<td>Prioritization of Product Ideas:</td>
<td>Prioritization of Ideas:</td>
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<td>• Market Size</td>
<td>• Structuring hierarchies between criteria and alternatives</td>
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<tr>
<td>• Market Growth</td>
<td>• Setting Priorities through Comparative Judgements</td>
<td>• Priorities among the elements of the hierarchy</td>
</tr>
<tr>
<td>• Value to market</td>
<td>• Calculus of priorities and test of consistency for each matrix</td>
<td>• Selection of the best product ideas to develop</td>
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<tr>
<td>• Social Impact</td>
<td>• Hierarchical synthesis of priorities</td>
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<tr>
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# MARKET ATTRACTIVENESS

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Rule of Thumb: C.R. ≤ 0.1 indicates sufficient consistency

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# TECHNOLOGY FEASIBILITY

## Technical Feasibility

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</tbody>
</table>

### Priority

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<th>T3</th>
<th>T4</th>
<th>T5</th>
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<td>0.333</td>
<td>0.474</td>
<td>0.158</td>
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<td>0.2</td>
<td>0.158</td>
<td>0.158</td>
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</tbody>
</table>

### Column Total

|                        |       |       | 3.53 | 3.67 | 15   | 6.33 | 6.33 |

### Rule of Thumb: C.R. ≤ 0.1 indicates sufficient consistency

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<tr>
<th>T1</th>
<th>T2</th>
<th>T3</th>
<th>T4</th>
<th>T5</th>
<th>Row Total</th>
<th>Vector Lambda</th>
</tr>
</thead>
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### Congruence Calculus

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<th>CI</th>
<th>CR</th>
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<td>0.06410714</td>
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## COMMERCIALIZABILITY

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<th>C2</th>
<th>C3</th>
<th>C4</th>
<th>C5</th>
</tr>
</thead>
<tbody>
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<td>C1</td>
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<td>3</td>
<td>0.33</td>
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<tr>
<td>Technical Convenience</td>
<td>C2</td>
<td>0.33</td>
<td>1</td>
<td>0.33</td>
<td>0.33</td>
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<tr>
<td>Economical Convenience</td>
<td>C3</td>
<td>3</td>
<td>3</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Political Convenience</td>
<td>C4</td>
<td>1</td>
<td>3</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Geophysical Aptness</td>
<td>C5</td>
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<td>5</td>
<td>2</td>
<td>1</td>
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</table>

<table>
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<th>C2</th>
<th>C3</th>
<th>C4</th>
<th>C5</th>
</tr>
</thead>
<tbody>
<tr>
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<td>C1</td>
<td>0.136</td>
<td>0.2</td>
<td>0.071</td>
<td>0.231</td>
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<tr>
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<td>0.214</td>
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<td>0.214</td>
<td>0.231</td>
</tr>
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<td>0.333</td>
<td>0.429</td>
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</table>

| Column Total                 | 7.33| 15  | 4.67 | 4.33 | 3.2  |

| Rule of Thumb: C.R. ≤ 0.1 indicates sufficient consistency |
|-----------------|----------------|----------------|----------------|----------------|----------------|
| C1              | 0.159          | 0.194          | 0.081          | 0.219          | 0.158          |
| C2              | 0.053          | 0.065          | 0.081          | 0.073          | 0.063          |
| C3              | 0.477          | 0.194          | 0.242          | 0.219          | 0.158          |
| C4              | 0.159          | 0.194          | 0.242          | 0.219          | 0.316          |
| C5              | 0.318          | 0.323          | 0.484          | 0.219          | 0.316          |

| Vector Lambda    | 5.095629381    | 5.326041016    | 5.161212011    | 5.258312999    |

<table>
<thead>
<tr>
<th>Congruence Calculus</th>
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<tbody>
<tr>
<td>Lambda max=</td>
</tr>
<tr>
<td>CI=</td>
</tr>
<tr>
<td>CR=</td>
</tr>
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</table>
## GENERAL CRITERIA

### Evaluation of the product idea

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<th></th>
<th>M</th>
<th>T</th>
<th>C</th>
</tr>
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<tbody>
<tr>
<td>Market Attractiveness</td>
<td>1.0</td>
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<td>2.0</td>
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<tr>
<td>Technical Feasibility</td>
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<td>1.0</td>
<td>2.0</td>
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<tr>
<td>Commercializability</td>
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<td>0.5</td>
<td>1.0</td>
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</table>

<table>
<thead>
<tr>
<th>Priority</th>
<th>M</th>
<th>T</th>
<th>C</th>
</tr>
</thead>
<tbody>
<tr>
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**Column Total:** 3.5  2  5

**n = 3**

**Rule of Thumb:** C.R. ≤ 0.05 indicates sufficient consistency

### Congruence calculus

<table>
<thead>
<tr>
<th>M</th>
<th>T</th>
<th>C</th>
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<th>Vector Lambda</th>
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</thead>
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<tr>
<td>0.312</td>
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<td>0.952</td>
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# EVALUATION OF THE PRODUCT IDEA

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<th>Market Attractiveness</th>
<th>Technical Feasibility</th>
<th>Commercializability</th>
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<tbody>
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<td>0.49047619</td>
<td>0.197619048</td>
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<tr>
<td>Technical Feasibility</td>
<td>0.49047619</td>
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<tr>
<td>Commercializability</td>
<td>0.197619048</td>
<td>0.197619048</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th></th>
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</thead>
<tbody>
<tr>
<td>Market Attractiveness</td>
<td>0.091</td>
<td>0.056</td>
<td>0.255</td>
<td>0.299</td>
<td>0.244</td>
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<td>0.027</td>
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<td>0.063</td>
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<td>0.064</td>
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<tr>
<td>Technical Feasibility</td>
<td>0.091</td>
<td>0.056</td>
<td>0.255</td>
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<td>0.244</td>
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<td>0.315</td>
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<tr>
<td>Commercializability</td>
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<td>0.056</td>
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<td>0.158</td>
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