

Technology transfer roadmap for small firms: theoretical bases

Roteiro de transferência de tecnologia para pequenas empresas: bases teóricas

Recebido: 15/03/2022 | Aceito: 10/05/2023 | Publicado: 15/06/2023

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Abstract

The paper seeks to explain the importance of technology transfer for small firms. The technology transfer plan fits inside the Technology Plan of the Business Plan. Some suggestions give the framework for small firms to process a strategy and avoid failure in the technology cycle. The paper has a didactical purpose and uses bibliographic research to give the pieces of information and the logic of the process. The result is to inform and clarify its importance in a Business Plan somewhere missed in the general education and standard templates, but that is important for small firms to cure.

Keywords: Business Plan. Technology Plan. Technology Transfer. Technology readiness level

Resumo

O artigo procura explicar a importância da transferência de tecnologia para as pequenas empresas. O plano de transferência de tecnologia se enquadra no Plano de Tecnologia do Plano de Negócios. Algumas sugestões fornecem a estrutura para que as pequenas empresas processem uma estratégia e evitem o fracasso no ciclo tecnológico. O trabalho tem finalidade didática e utiliza a pesquisa bibliográfica para fornecer as informações e a lógica do processo de transferência da tecnologia. O resultado é informar e esclarecer sua importância em um Plano de Negócios em algum lugar perdido na educação geral e nos modelos padrão, mas que é importante para que as pequenas empresas cuidem.

Palavras-chave: Plano de Negócios. Plano de Tecnologia. Transferência de Tecnologia. Nível de prontidão tecnológica.

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Introduction

Technology transfer is a complex process that encompasses many elements and must be defined into a firm Technology Plan. A technology plan is one of the main strategy when a firm starts a business plan like marketing, organization, and financials. Not every small firm develops a business and its technology plan, even if recommended. A study of literature and business practice could suggest, along with a consultancy, some tools to perform decisions.

A small firm could use in Brazil the S System that offers tools, courses, consultancy, and intellectual propriety and could be supported by IES or *Instituições de Ensino Superior* (High school institutions) that have professionals prepared and skilled to perform research and handle such a problem. A University department or center like NIT *Núcleos de Inovação Tecnológicas* or Technological Innovation Centers could be useful to perform this task.

A problem to be solved by a small firm is to have a base of information to understand how to organize a technology plan where to find information and reliable indication. The objective of this didactical work is to explain a framework the technology plan and to achieve the transfer technology process or plan technology into the Business Plan (BP) based on academic and work experience to be disposable also to graduated students of administration, public administration, and law students.

The paper complements other author's works about business plan and entrepreneurship published as a didactic support for all students. It is a revision of methods and suggestions.

Methodology

The paper justifies itself to be an educational and short summary of Technology plan and Technology Transfers and how to develop such a plans for small firms. These indications are disposable for academic purposes to all readers, graduated students of administration, public administration, and law students.

The author's experience as a teacher and professor of intellectual property master's degree as well as professional activity and consultancy is summarised in this paper to help with these processes and follow many papers about business plans and new entrepreneur's support.

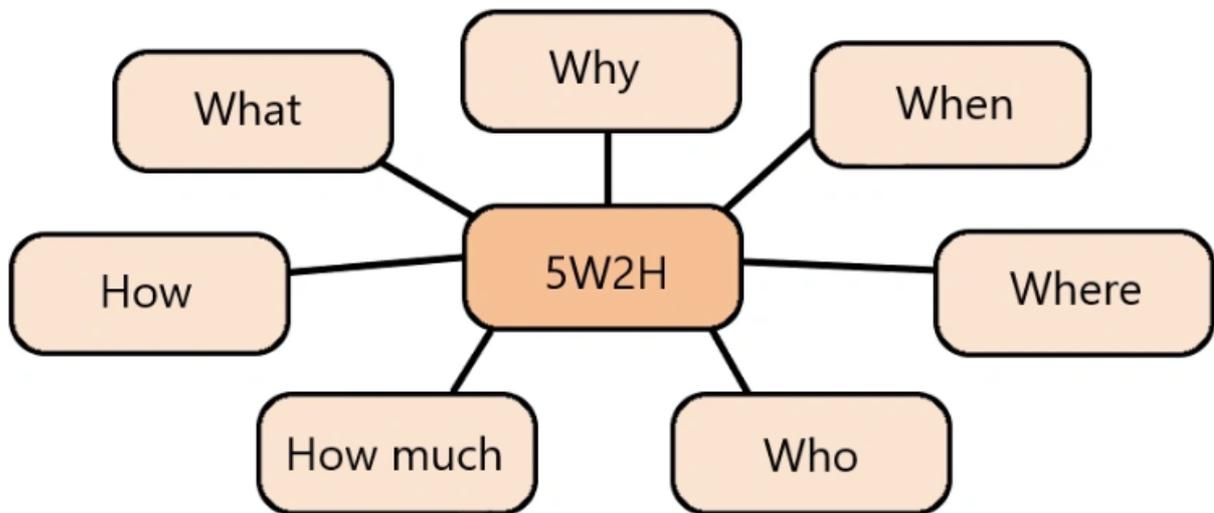
The method used in the paper sequence is bibliographic. The text collected definitions, explanations, and suggestions about technology plans and technology transfer. It starts with a short introduction, explain what is a Technology plan and its main section, or technology transfer, and which process is better to follow to include technology transfers into business plans. A concluding remark ends the paper.

Business Plan and technology level.

A business plan is always a written document with standard information. That is the mission, strategy, and goals of a business, the organization of the business, the methods for attaining those goals and the marketing plan, the time-frame for the achievement of the goals, and financial elements as well as an investment plan (AVENI 2013).

In a specific and separate section, it can also describe the nature of the business, background information, internal/external analysis as well as the opportunities and innovations. It intends to explain to different kinds of stakeholders the targets of the firm. The document serves also as a road map that provides direction to the business and a road map can be drafted to complement Gantt or scheduling graphics.

A business plan generally is developed from a 5W2H logic scheme. The is in



summary a few question about he business or:

- What: The purpose/mission of the project and/or the improvement goal to achieve;
- Who: who is and which organization is responsible for solving the problem or opportunity for improvement;
- Where: The physical place but also a specific economic sector or even in which operation or production the organization operates;
- Why: define the reason why solving this problem or reaching the proposed goal is important and the value offered to clients;
- When: is the time when the problem occurs and what is the deadline for resolution;
- How: how works the process;
- How much: inform quantity prices, cost, and profits

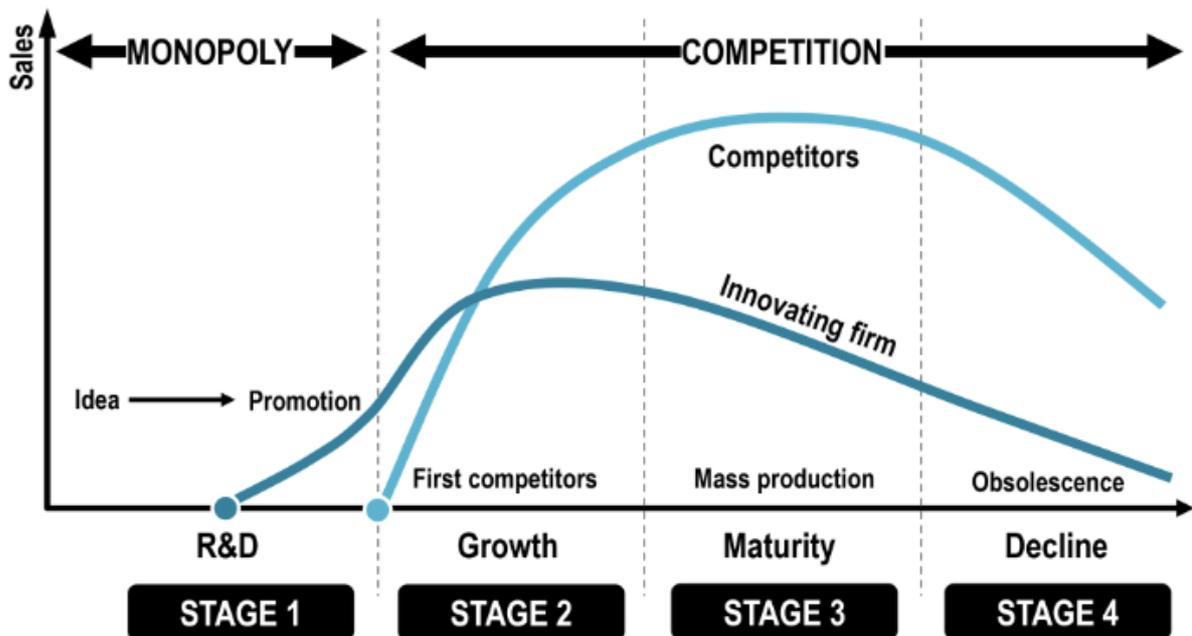
To answer these questions, a firm writes a business plan because it is also required to obtain a bank loan or other financing. There are many templates and guides, that can be used to facilitate producing a business plan. This document, with its crono-program (a gaunt chart for instance) of activities and goals, serves as a road map that provides direction to the business, adding milestones and turning points to control the process (the ongoing flow of the plan).

Usually, the plan has an Organisation a Marketing plan, and a Financial plan. Inside these main areas, there are embodied some other plans about the specificity of the business. For example, a plan to develop a Brand is included in the marketing plan, and a plan to raise funds and capital is included in the financial plan. Another plan is about managing human resources or information technology as a support for value creation.

A technology plan is necessary mainly when the startup or the firm main value chain and concurrency position depend in some way on technology. It means to seek and control the product or service cycle of the firm. This is not only to follow the product cycle or the five common stages that make up a product cycle marketing oriented. These are:

Development/Planning
 Introduction/initiation
 Execution/sales
 Maturity/Growth
 Decline

Product Life Cycle



The figure above explain something more or the market-firm relation when the product cycle advance.

figure 1 - Product life cycle

source; <https://transportgeography.org/contents/chapter7/freight-transportation-value-chains/product-life-cycle/>

By seeking the technological plan it is important to understand the level of technology used in the product life cycle and the program to manage the technology process cycle from R&D till the decline steps.

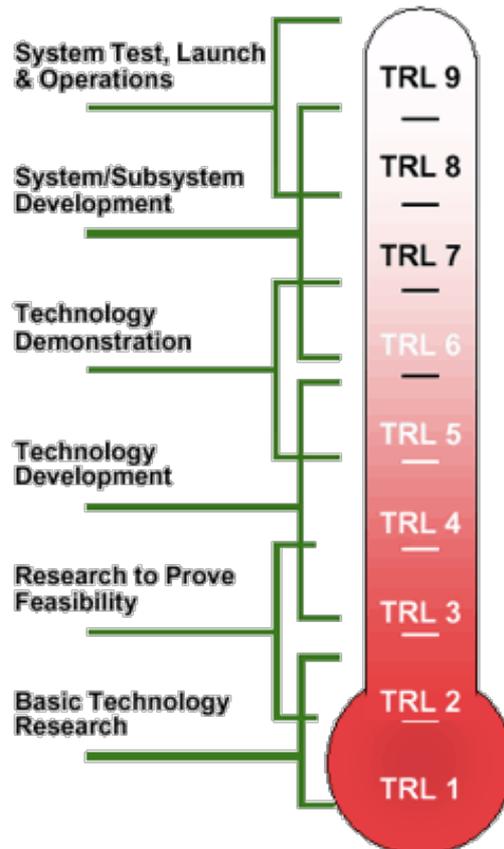
The Readiness Level index is used, from an initial definition of NASA in the following figure above and shows the different stages between a decision on a technology and the complete process (operations).

For a technology homemade building process it seems probable that part of the organization will be dedicated to. But when the technology is transferred or purchased sometimes no organization follows it but the entrepreneur itself. And this is the small firm case.

So a technology transfer into a technology plan, as we are describing forward, look at the readiness level for every phases of the product life cycle. It is important

before and after the purchase of the technology have a look on the index, and in the market because the operations will depend not on the firm knowledge but on the external supplier and a whole technology development sometimes is an asymmetric information.

figure 2 - RTL system



source: <https://esto.nasa.gov/trl/>

In other words, if a firm is planning to launch a product or service which depends on exterior technology it is extremely risky not to plan an alternative technology or to have a solid maintenance contract with the owner of the technology. This is only possible with technology transfer contracts or agreements.

In case the technology is not developed inside the firm the index for the transferring technology must be known and so all informations about how the provider of the technology have planned to perform the technology cycle of its technology transfer.

The Technology Plan (TP) into the Business Plan (BP) could be summarise into these few points:

- who's responsible of the TP ?
- is the plan monitored and integrated with all decisions of the firm and BP?
- which technology readiness level for each product or service into the product cycle of the firm defined into a BP?

Technology transfer

Technology Transfer occur in several ways and encompass different situations or forms. Main forms of technology transfer, from contracts, to licensing, and open innovation. The Intellectual Property is the main form to transfer technology. A list of technology transfer option or types could be the following²:

- Patent License Agreements
- Open Source Software Releases
- Cooperative Research and Development Agreements
- Education Partnership Agreements
- Technology Transfer Sharing Agreements

There are many agencies to help small firms to transfer technologies too, i.e. university (or basic research) or business (or innovation). Interaction is achieved through technology transfer offers. Technology transfer is a complex process. It is closely related to knowledge transfer because some technique of the new technology often occurs with some strong competence of someone involved in the transfer. Transfers may occur in many ways between universities, businesses, and governments, across geopolitical borders, both formally and informally, and both openly and secretly. This could occur by sharing skills, knowledge, technologies, manufacturing methods, samples, and facilities among the participants.

Technology transfer can involve highly complex technology from capital-intensive origins to low-capital recipients it also can involve not necessarily high-tech or expensive. For instance, using networks, technological developments are accessible to a wider range of users who can then further develop and exploit the technology into new products, processes, applications, materials, or services. The transfer process in a network could be a horizontal transfer, or the movement of technologies from one area to another But could occur with vertical transfers within the areas., or occurs when technologies are moved from a research center to development departments.

Another way to develop invocations and promote technology transfer is by brokers and specialized centers. Brokers are people who discovered how to bridge scientific concepts or processes to new products or services. Other centers work within the triple helices concept, or cooperations between universities, private centers, and government agencies. Many companies, universities, and governmental organizations now have an Office of Technology Transfer. The term “partnership intermediary” means agencies that could assist, counsel, advises, or cooperates with firms.

The process of commercially exploited technology transfers can involve licensing agreements or setting up joint ventures and partnerships to share both the risks and rewards of bringing new technologies to market. Could need the creation of startups or spin-outs. When the problem is to rise capital is used by venture capital agents or other forms of funding the development process. As a result of the potential complexity of the technology transfer process, technology transfer organizations include a wide group of experts like economists, engineers, lawyers, marketers, and scientists.

Indicators to determine a level of complexity of a technology transfer .such as the stage of technology level is the Technology Readiness Level (TRL) must focus on TRL 6–7 or higher. The passage from TRL-3 to TRL-6 or to rush prototypes into production, create a process fully tested under diverse conditions, reliable, maintainable,

² <https://www.nsa.gov/Research/Technology-Transfer-Program/Types-of-Technology-Transfer/>

tends to be costly and more time-consuming than expected so has proven to be difficult and more challenging for most organizations.

The Small firm could choose to be part of a developing network of new technologies to discount the cost of the transfer but this participation on open innovation could be handled only if there are skills into the small firm and all asymmetries of information are avoided. In sum being part of a developing technology to assure a local competitive position is risky and could impact all the business. However it could be a wise choice if everything going well and all process could be controlled and planned. It must be write a very good contract and there must be a trusting relation between all participants.

Technology transfer and small business

Following Cook and Nixon's (2000) study about the recognition of the role of SMEs in the development process in many developing countries, one has to agree that SME development is always constrained by the limited availability of financial resources to meet a variety of operational and investment needs.

A World Bank study claims that about 90% of small enterprises are saying that credit is a major constraint to new investment (Parker et al., 1995). That conclusion is corroborated by Levy (1999) that there is limited access to financial resources available to smaller enterprises compared to larger organizations as the role of finance has been viewed as a critical element for the development of SMEs (COOK AND NIXSON, 2000).

Because a large portion of the SME sector does not have access to adequate and appropriate forms of credit and equity, they have a different attitude toward technology transfer from the large corporates. The last group could buy or negotiate patents, for example, the smaller firms need to buy new products that already include new technologies. In other words, the small firms could not invest time and money to develop TRL stages 1 to 3.

So small businesses are more involved in technology transfer dissemination and the contribution of refining new technology using them in their business. This work could be part of marginal innovations or modifications of the technology to fit customers' needs, not perceived in the launch phase of the product or service by the intellectual or industrial owner of the patents.

This marginal process of technology transfer is underestimated because not always the suggestions and the modifications are included in the original patent originating some fees or intellectual propriety rights. In general, there is a gentlemen's agreement of some sort that exchanges minor innovations or the refining process of the new product or service with discounts or another benefit clause in the licensing contract.

The general process used by the small business firm is a Manufacture Agreement which is a framework when the Client wishes the manufacturer to design, manufacture and deliver goods that the Client intends to integrate into its final products or services, and therefore must meet certain specific requirements of the Client.

This contract provides a series of possibilities depending on the background and the nature of the production. Many provisions may not be relevant to the particular contract and should, if not relevant, be deleted. The contract provides for a basic scheme based on the assumption that the manufacturer is fully equipped and has the technology to produce goods or services and needs certain specific equipment or tooling that has to be transferred to enable him to finalize the products

In the contract, the manufacturer shall submit samples before production is launched and be adapted to the specific needs but they are not exclusive of each other and may be combined assuming that the intellectual property rights are properly protected by appropriate registration by the vendor and imposes a duty of confidentiality upon both parties, which should provide additional protection in particular if know-how is communicated by one party to the other. The cooperation of the Parties might be a contract of duration. It is therefore important to establish the duration of the alliance

The great part of the small business firm didn't follow a process and a plan to include a technology transfer into an integrated product or service process cycle. If the firm lost the integrations phase the effects are in efficiency and strategic planning that impact firm sustainability or long-term competition against more organized competitors.

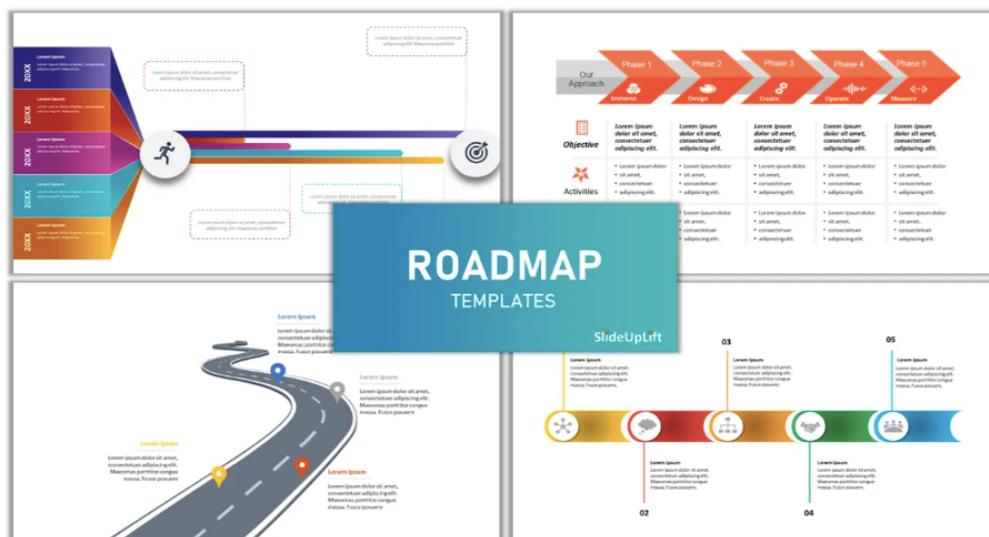
So one way to reduce the risk of loss of efficiency and to act like a much greater firm is to follow a road map to avoid mistakes and risks. A "road map package" must provide the following support:

- help to research the best technology and technology transfer licenses for the firm process
- help to provide all the agents and organizations involved with a specific technology to let the firm contact as many the firm will do it.
- help to support with facsimile or standard contract, and with legal associated attorneys to define the technology license terms and clauses of the final contract.
- help to find associated or network firms and developers to include the technology in the production process.
- monitor and control the overall roadmap and the timing of the roadmap

The result of the technology plan (TP) and the transfer of technology: the Roadmap.

The following figure explains what is the roadmap of the technology plan. It is a way to figure a chronological step by step process.

Figure 3 - Roadmap



source: <https://slideuplifts.medium.com/perfect-roadmap-slides-to-build-your-2020-strategy-a08bd2f1b549>

The use of Technology Transfer depends on a technology strategy defined by the firm. Small firms neglect formal strategic plans, but to help us support them is important to understand the technology strategic framework in which they perform.

The main function of Technology exploration or needs assessment could be performed, as well the other phases of the plan with a roadmap. This will be discussed further in this section. The technology must fit the mission after starting a roadmap and systematic exploration. A needs assessment describes all matter the firms need to perform and the use of technology transfer to improve the performance.

A clear definition of hardware, software, and instructional resource requirement, must be coordinated with a staff development plan and a monitoring and controlling process. These last tasks must enter into the strategy as budget, evaluation method, and funding source/amount/timeline.

A technology roadmap could be considered as a tool or a flexible planning technique and support strategic technology planning, by matching short-term and long-term goals with specific technology solutions. Road map It is a known technique to help manage innovation and can be combined with other corporate foresight methods.

Developing a roadmap has these effects:

- a) it helps formalize a set of needs and the technologies required to satisfy those needs;
- b) it provides a standard process to help forecast and measure results;
- c) It is also an analysis tool to map the development and emergence of new needs.

In general, a roadmap process contents a) the Preliminary phase (in which the key decision makers must identify a problem and how to solve the problem) b) the Development phase (which consists in the following steps identify the technology that is the focus of the transfer and the roadmap, the critical system requirements, their targets, the technology drivers, technology alternatives, and their timelines, and create a report of all this); c) Follow-up activity phase (in which the roadmap must be critiqued, validated and accepted).

So the Technology Transfer roadmap that focused on more than one transfer must be a combined process as a project portfolio, in which some activity must precede others, or must be postponed waiting for other results. The technology transfer roadmap could be combined in a more complex technology plan for the firm joining internally developed technology, externally developed, network and parallel developed technologies.

In other words, a roadmap could be very complex even for a small firm to manage. A tool that supports the firm could be helpful even if the CEO of this firm doesn't use formal technology plans. Roadmap asses and supports decisions because is a standard tool and could be simplified as a series of questions to develop a "road" to achieve the final objective of the Technology Transfer problem.

First, a question: do you need a project roadmap? A road mapping tool could be performed without digital tools, but using software to support make your job easier and centralize all the process, increase transparency across your entire organization, and improve productivity.

A road map could present as a "virtual" road or a Gantt map that encompasses all processes. The main problem is to define a platform and have the necessary training to fill out the form and uses the functions of the platform chosen. Between the functions of a Technology Transfer roadmap must be considered contracts and intellectual propriety. As a roadmap couldn't perform this task for all the situations, there must be here a step-by-step methodology to perform this task. In this case, the road map could fix some engagement rules to perform and which is the best decision at this point.

Here the alternatives must be well defined if the firm would be interested in buying technology only with a product (equipment) or services. In other cases, there must be defined a contract for different types of technology transfer and all network processes. Mixed cases could be developed as contract management by specialized attorney firms.

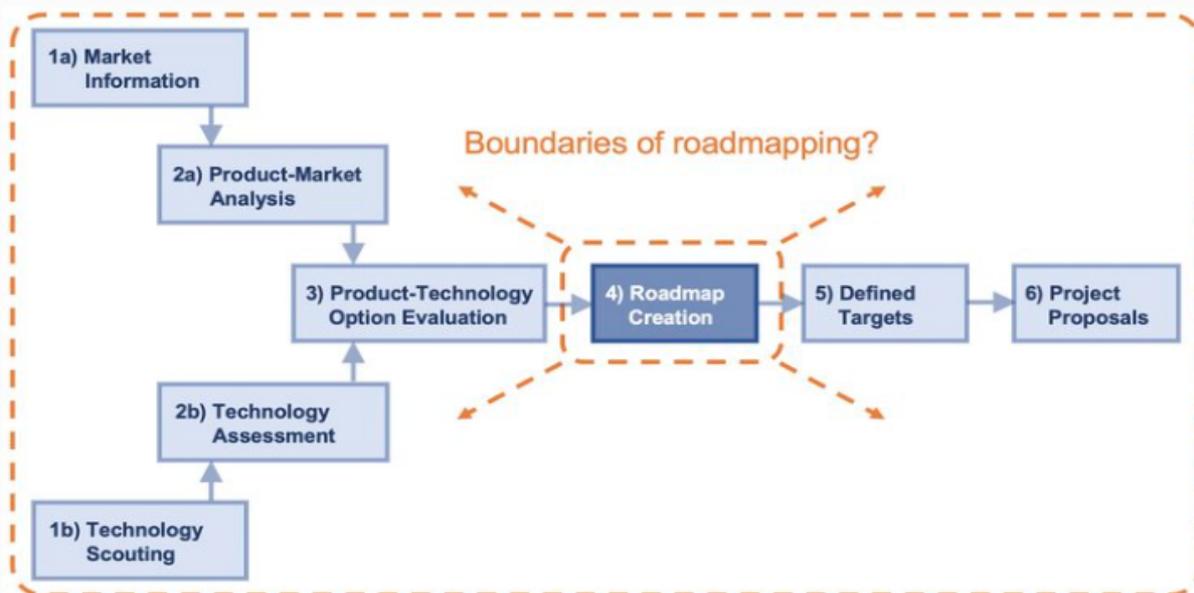
Some agencies, or Universities could support a technology transfer process, but we found this as internal support more than external consultancy. In Brazil, this consultancy could be done by the S System eventually. The reason why could be encountered into a cultural and competence lack of skills. An automated or digital application could be a solution to attend many small business firms. The offer should be complemented by a training course or some free support.

That is a recursive process that must be developed in steps. It is required to work by product defining the technology area and the technology drivers. It is necessary to define which results are expected from the workshops that are necessary to perform the process to create a roadmap.

The great question to establish a roadmap is if we are seeking alternatives or if we don't want to change technologies. In the last case, the roadmap will be running forward but if we seek alternatives for every milestone or point of choice it is important to develop a specific road. At last the roadmap with alternatives could converge but it is necessary to evaluate the costs of alternatives or a cost-benefit analysis.

TA process to perform the task of developing a road map could be the following shown in the figure above. The following figure explain what is a roadmap of the technology transfer process inside the small firm.

figure 4 - Roadmap creation proces



Roadmapping in Philips' innovation process (EIRMA, 1997)

source: <https://www.cambridgeroadmapping.net/roadmapping-as-process>

Concluding remarks

The paper discussed The TP and transfer of technology in a market, business and managing point of view. The limit of the research is about the legal framework that must be also analysed having care of local Intellectual Property legal framework and eventually international patents and certification marks.

A Technology Plan TP and the resulting roadmap could be reduced and compressed in time as an exercise. If there are all pieces of information and support a quick decision could be developed. The technological plan however is not something that must be forgotten in a drawer. Following the product or service market developing cycle the technique embedded and its consequent technological level must be monitored.

As an example, today's delivery of the supply chain could be hired to the limit to have a drone delivery. This is an example of the technological level of suppliers that affect directly the technological plan of the firm because, for instance, to use the new service as a competitive position, the firm technology will change, at least to change the package and its weight.

So a Technology Plan TP and the decision between homemade or technology transfer fit into transversal decisions that affect or are affected by marketing and organization plans. It is a recursive process never ending.

Neglect to work on technology plans and coordinates them with business plans put the firm at risk. The risk is a continuous time-costly "extinguishing fires" everyday work inside to taking care of business.

References

AVENI A. em CDT Centro de Apoio ao Desenvolvimento Tecnológico - CDT Universidade de Brasília - UnB - **INTRODUÇÃO À ATIVIDADE EMPRESARIAL Módulo: Plano de Negocio** pag 30-81. 2013

COOK, P. AND NIXSON, F. (2000). Finance and Small and Medium-Sized Enterprise Development. IDPM, University of Manchester, **Finance and Development Research Programme Working Paper Series**, Paper No 14.

Useful links:

BRASIL. **Lei 10.973, de 2 de dezembro de 2004. Dispõe sobre incentivos à inovação e à pesquisa científica e tecnológica no ambiente produtivo e dá outras providências.** Brasília, DF, Presidência da República, 2004. Disponível em: http://www.planalto.gov.br/ccivil_03/_ato2004-2006/2004/lei/l10.973.htm

BRASIL. **Lei 13.243 de 11 de janeiro de 2016. Brasília, DF, Presidência da República, 2016. Dispõe sobre estímulos ao desenvolvimento científico, à pesquisa, à capacitação científica e tecnológica e à inovação e altera a Lei nº 10.973, de 2 de dezembro de 2004, a Lei nº 6.815, de 19 de agosto de 1980, a Lei nº 8.666, de 21 de junho de 1993, a Lei nº 12.462, de 4 de agosto de 2011, a Lei nº 8.745, de 9 de dezembro de 1993, a Lei nº 8.958, de 20 de dezembro de 1994, a Lei nº 8.010, de 29 de março de 1990, a Lei nº 8.032, de 12 de abril de 1990, e a Lei nº 12.772, de 28 de dezembro de 2012, nos termos da Emenda Constitucional nº 85, de 26 de fevereiro de 2015.** Disponível em:< http://www.planalto.gov.br/ccivil_03/_ato2015-2018/2016/lei/l13243.htm>

BRASIL. Ministério de Ciência, Tecnologia, Inovações e Comunicações. Relatório FORMICT 2017. Política de Propriedade Intelectual das Instituições Científicas, Tecnológicas e de Inovação do Brasil. Brasília, DF, 2019. Disponível em: http://antigo.mctic.gov.br/mctic/export/sites/institucional/tecnologia/propriedade_intelectual/arquivos/Relatorio-Consolidado-Ano-Base-2017.pdf

BRASIL. Ministério de Ciência, Tecnologia, Inovações e Comunicações. Relatório FORMICT 2018. Política de Propriedade Intelectual das Instituições Científicas, Tecnológicas e de Inovação do Brasil. Brasília, DF, 2019. Disponível em: http://antigo.mctic.gov.br/mctic/export/sites/institucional/tecnologia/propriedade_intelectual/arquivos/Relatorio-Consolidado-Ano-Base-2018.pdf

CAMBRIDGE <https://www.cambridgeroadmapping.net/roadmapping-as-process>
Confederação Nacional da Indústria (CNI). **Mobilização Empresarial pela Inovação: cartilha: gestão da inovação.** Brasília, 2010.

NASA - <https://esto.nasa.gov/trl/>

NSA <https://www.nsa.gov/Research/Technology-Transfer-Program/Types-of-Technology-Transfer/>

OCDE. MANUAL FRASCATI: Metodologia Proposta para a Definição da Investição e Desenvolvimento Experimental. Edição F. Iniciativas – Portugal, 2002.

OCDE. Manual de Oslo: Diretrizes para a Coleta e Interpretação de dados sobre Inovação Tecnológica. Rio de Janeiro: FINEP, 2005. Disponível em: http://www.oecd-ilibrary.org/science-and-technology/manual-de-oslo_989264065659-es.

Serviço de Apoio às Micros e Pequenas Empresas do Paraná – SEBRAE-PR. **Guia para a Inovação: Instrumento de orientação de ações para melhoria das dimensões da inovação.** Paraná, 2010.

Serviço de Apoio às Micros e Pequenas Empresas - SEBRAE. **Perfil da Microempresas e Empresas de Pequeno Porte.** Brasília, 2018.