Latin American Business Review

ISSN: 1097-8526 (Print) 1528-6932 (Online) Journal homepage: http://www.tandfonline.com/loi/wlab20

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To cite this article: Mario José Mantulak, Gilberto Hernández Pérez & Juan Carlos Michalus (2016) Definition Procedure for Strategic Technology Resources in Small Manufacturing Firms: A Case Study, Latin American Business Review, 17:2, 95-113, DOI: 10.1080/10978526.2016.1171674

To link to this article: http://dx.doi.org/10.1080/10978526.2016.1171674

Published online: 30 Jun 2016.

LATIN AMERICAN BUSINESS REVIEW
2016, VOL. 17, NO. 2, 95–113
http://dx.doi.org/10.1080/10978526.2016.1171674

Routledge
Taylor & Francis Group

Definition Procedure for Strategic Technology Resources in Small Manufacturing Firms: A Case Study

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ABSTRACT

In the Latin American context, small manufacturing firms are subject to severe constraints on their competitiveness due to significant technological lags in their production processes and shortcomings in their technology management activities. Further, this business segment also encounters major hurdles that hamper its access to a broad range of State science and technology promotion tools. This is why it is necessary to deploy a procedural tool that paves the way for technology resource management practices that are both systematic and ongoing, particularly those that are strategic for upgrading the production performance of these enterprises. This article explores the development of a procedure for defining strategic technology resources and their application in a small sawmill. In order to respond to the proposed objectives, a nonexperimental research project was conducted through a descriptive study that included a sector-specific diagnosis, the use of strategic analysis tools for assessing tangible and intangible technology resources, and analyses of key factors (internal) and sector-specific influence factors (external). The most noteworthy result is the construction of a methodological procedure that helps fine-tune the use of existing technology resources through an initial technology diagnosis. The application of the procedure streamlines the decision-taking process for technology innovation and management in a small company, enhancing its production performance. The progress of the survey also helped bridge the gap between academic theorization and corporate pragmatism, with specific input spurring local and regional development. As a result, it would be appropriate for future research projects to explore the impacts caused by the implementation of the procedure on the technology management indicators of small businesses in this sector.

RESUMEN

En el contexto latinoamericano las pequeñas empresas manufactureras enfrentan fuertes limitaciones de competitividad, en virtud de un significativo rezago tecnológico en sus procesos de producción y deficiencias en las actividades de gestión de sus tecnologías. Asimismo, existen marcadas dificultades en este segmento de empresas para el acceso a los diversos instrumentos estatales de promoción científica y tecnológica. Es por ello que resulta necesario disponer de una

ARTICLE HISTORY
Received 25 November 2015
Revised 27 December 2015
Accepted 5 February 2016

KEYWORDS
Manufacturing firms; small enterprises; technological resources

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herramienta procedimental que favorezca la implementación de prácticas sistemáticas y sostenidas que posibiliten gestionar los recursos tecnológicos, en particular aquellos que resulten estratégicos para favorecer al mejoramiento del desempeño productivo de estos emprendimientos. Los objetivos del trabajo se centraron en el desarrollo de un procedimiento para determinar los recursos tecnológicos estratégicos, y su aplicación en una pequeña empresa de aserrío. Para atender los objetivos propuestos se realizó una investigación del tipo no experimental, a través de un estudio descriptivo que incluyó un diagnóstico sectorial, la utilización de herramientas de análisis estratégico para evaluación de recursos tecnológicos tangibles e intangibles, el análisis de factores clave (internos) y de factores influyentes sectoriales (externos). Como resultado principal se destaca la construcción de un procedimiento metodológico que posibilita mejorar la utilización de los recursos tecnológicos existentes, a partir de un diagnóstico tecnológico inicial. La aplicación del procedimiento contribuyó a mejorar el proceso de toma de decisiones referidas a la gestión e innovación tecnológica en la pequeña empresa y su desempeño productivo. El desarrollo de la investigación coadyuvó también al cierre progresivo de la "brecha" existente entre la teorización académica y el pragmatismo empresarial, posibilitó un aporte concreto al desarrollo empresarial local y regional. En función de lo realizado, se considera oportuno analizar en futuras investigaciones, los impactos que provoca la implementación del procedimiento en los indicadores de gestión tecnológica de las pequeñas empresas de este sector.

RESUMO

No contexto latino-americano as pequenas empresas manufatureiras enfrentam fortes limitações de competitividade, em virtude de um significativo atraso tecnológico em seus processos de produção e de deficiências nas atividades de gestão de suas tecnologias. Nesse segmento de empresas também há dificuldades evidentes no que tange ao acesso aos diversos instrumentos estatais para a promoção científica e tecnológica. Portanto, é necessário dispor de uma ferramenta procedimental que propicie a implementação de práticas sistemáticas e sustentáveis que possibilitem a gestão dos recursos tecnológicos, notadamente dos que são estratégicos para favorecer a melhora do desempenho produtivo de tais empreendimentos. Os objetivos do presente trabalho estão centrados no desenvolvimento de um procedimento para a determinação dos recursos tecnológicos estratégicos e sua aplicação numa pequena empresa: uma serraria. Para alcançar os objetivos propostos foi realizada uma pesquisa não experimental, através de um estudo descritivo que incluiu um diagnóstico setorial, o uso de ferramentas de análise estratégica para a avaliação dos recursos tecnológicos tangíveis e intangíveis, e a análise dos fatores-chave (internos) e dos fatores de influência setorial (externos). Como resultado principal destaca-se a elaboração de um procedimento metodológico que possibilita a melhoria do uso dos recursos tecnológicos existentes a partir de um diagnóstico tecnológico inicial. A aplicação do procedimento contribuiu para melhorar não só o processo decisório referente à gestão e inovação tecnológica na pequena empresa, mas também o desempenho produtivo. O desenvolvimento do estudo também contribuiu

para o estreitamento progressivo da lacuna existente entre a teorização acadêmica e o pragmatismo empresarial, e possibilitou um aporte concreto para o desenvolvimento empresarial local e regional. Em virtude do que foi realizado, considera-se oportuno instar que pesquisas futuras analisem o impacto da implementação do procedimento nos indicadores de gestão tecnológica das pequenas empresas deste setor.

Introduction

In production companies, proper management of technology resources ensures better adaptation between workers and their tools and equipment, while also paving the way for higher output by both of them. This is similar to the remarks of Navarro, Romero, Bauza, and Granadillo (2006), who noted that business organizations must focus their efforts on upgrading the quality of machinery and human resources, as the generation of new ideas and knowledge embodied in physical equipment and people constitute the intangible capital that is crucial for boosting corporate productivity levels and ensuring a keener competitive edge.

Good corporate deployment of technology resources implies the need to foster and/or develop organizational capacities that allow for the use of certain knowledge, abilities, skills, and expertise by personnel in order to step up the efficiency of the machines and/or equipment with which they work, identified as distinctive elements that contribute significantly to the production performance of the organization. This is why it is necessary to assign strategic status to the technology function within the set of functional areas of the company.

More specifically, small businesses are subject to internal conditions that may constitute hurdles hampering business development and technological progress, due mainly to capital structure, types of management, and sales structures, which may well impose severe constraints on the use of internal knowledge and abilities, consequently curbing the possibilities of seizing nearby opportunities (David, 2008; Palomo, 2009). This view also aligns with authors such as Martín (1996), Caicedo (2008), Fierro and Gutiérrez (2009) and Leon and Valenzuela (2014), who stressed the existence of the set of positive aspects in small companies that indicate they are endowed with dynamic structural and organizational conditions underpinning a broad range of technology innovation and management activities that are crucial for production processes.

All business organizations must plan the use of their technology resources, ranking them by importance in the technology adaptation, acquisition, and/or generation process to define the technology course to be followed over the medium and long terms (Gutiérrez, Rebolledo, Ibarra, & Henneberry, 2008). This means that it is vital to develop an organizational culture efficiently, which ensures the company will remain at a technological level that is favorable for its business, tailored to its own capabilities, as well

as market demands. Thus, Campillo (2000) noted that the resources available to the company and its ability to acquire and/or generate other new resources must also be borne in mind when analyzing the factors that define specific strategic options in decisions related to in-house technology development.

In order to implement a well-planned process for taking strategic decisions on the course of technological development within the company, it is vital to conduct a detailed diagnosis that complements and connects soft and hard technologies, whether already in place and/or available, with other key corporate factors and the corresponding influences in their environments. Thus, a procedural tool is required that allows a comprehensive, overall analysis based on tangible and intangible technology resources, corporate strengths and weaknesses, and the opportunities and threats in its social and economic context, in order to pinpoint the strategic technology resources that can contribute substantially to boosting the production performance of the manufacturing firm.

Technology resources

From the business standpoint, resources generally consist of a set of tangible and intangible assets (goodwill included) available for pursuing the purposes of the company (Caves, 1980; Hill & Jones, 2011; Sáez de Viteri Arranz, 2000; Ventura, 2008) while Wernerfelt (1984) described a resource as any means that may be rated as a corporate strength or weakness. For Barney (1991), resources are the production factors controlled by the company for developing strategies that enhance its efficiency and efficacy.

From this same standpoint, Nuchera, Serrano, and Morote (2002) established the technologies related to the application of knowledge to the production of specific services and goods. Along the same lines, Sánchez (2005) noted that technology constitutes both knowledge and the outcome of its practical application. Moreover, he agreed with Porter (1985) when stating that in practice everything the company does requires some technology that is contained in both its core and support activities.

Meanwhile, Morin (1992) blended the concepts of resources and technology, affirming that technology resources constitute the set of tangible and intangible media available to the company and/or that it can access either internally (individual and collective capabilities and potential) or externally (current or potential stakeholders) for designing, fabricating, and selling its products or services, the use of information, and the management of all the functions that contribute to the materialization of its activities. Consequently, and for the purposes of this article, this definition is adopted as being appropriate to the goals of this research project, and is also pertinent to the type and characteristics of the companies addressed by this study.

Based on the matters presented, agreement is reached with Castells and Pasola (2005) when they argued that technological assets analyses should not be a minor activity, as they underpin diagnoses of the current status, serving as of foundation for technology development strategies, as well as with Ortega (1991), who believed that ongoing sustained enrichment of technological assets is achieved through introducing an organizational culture that buttresses creative thought and consequently the appearance of innovations.

Nevertheless, Morin (1985) warned about a management gap in coping with demands from the surrounding environment, facing the challenges of technological turbulence and establishing innovative development strategies, as senior management does not generally make good use of the expertise and creative flair of employees, with little interest in lowering internal and external barriers that block the efficient use of the available technological media. Consequently, it is vital that corporate directives use management tools that ensure comprehensive, overall definition of tangible and intangible technological media, while identifying internal and external hurdles hampering more effective use thereof.

As expressed, it is vital to stress that the efficient use of technology resources may be achieved only through effective strategic management, which builds up corporate technology assets in a comprehensive, integrated manner. Along these lines, Morin (1992) noted that the leader of the business organization must ensure true technology resource management based on the deployment of six key functions: optimize, enrich, safeguard, inventory, assess, and oversee.

Strategic technology management

Among the many authors defining strategic management in companies, Heracleous (1998) conceived this as a feedback process between strategic thinking that underpins the synthetic, divergent, and creative standpoint that reveals new strategies and imagines future competitive advantages, and strategic planning based on analytical, convergent, and conventional concepts that allow the implementation of strategies developed through strategic thinking.

Further, adding a few details, Hidalgo Nuchera (1999) defined technology management as "the process of managing all those activities that empower the company to make the most efficient use of technology generated in-house and acquired elsewhere, while also including it new products (product innovation) and the ways in which they are produced and delivered to the market (process innovation)."

This is in agreement with Moya (1997), who noted that strategic technology management may be considered as "the process of technology converging with other corporate functions in order to achieve strategic management of

the business." Pedroza (2001) went further in his definition of the impacts of the development of strategic technology management when noting that this occurs in the domain and under the control of certain technologies that generate some specific technological competencies (response to a strategic problem) for selecting product lines and markets, and the resulting corporate strategy.

Based on these comments, the objectives of this article are to develop a procedure that will define strategic technology resources in small manufacturing firms, checking the utility and pertinence of the procedure through its application to a case study.

Materials and methods

The research project giving rise to this article grounds its analysis on the importance of a proper diagnosis of the technological assets of small manufacturing companies, through a comprehensive assessment of their technology resources and key factors, together with influencing factors in their environments, using two data sources: a review of the literature and the application of the strategic technology resources definition procedure to a small sawmill in Argentina's industrial forestry sector.

The review of the literature was steered by concepts related to technology resources, technology, strategic technology management, and links among them. This analysis allowed a procedure to be drawn up for defining strategic technology resources in small manufacturing companies.

The experimental part of this research project consisted of applying the procedure to a small sawmill in the Misiones Province, Argentina, in order to ascertain the feasibility and pertinence of its implementation in the small manufacturing business segment.

Procedure developed

Within the framework of a broader-based research project (Mantulak, 2014), a wide-ranging review of the literature was conducted, which allowed the bases to be firmed up for preparing the procedure presented in this article.

The purpose of developing the procedure was to conduct a comprehensive, across-the-board analysis of technology resources, key factors for the company and influencing factors in its environment that allow the entrepreneur and his or her staff to establish a new way of analyzing and interrelating their technology resources, defining which of them are crucial for boosting the production performance of the company. To achieve this goal, a three-step procedure was designed (Figure 1) to identify and rank technology resources by priority that are strategic for the business, enhancing its key factors, while also considering the main external factors influencing the organization.

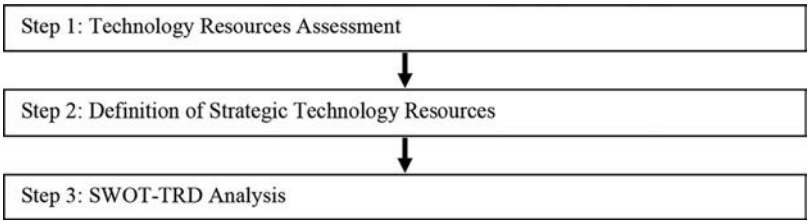

Figure 1. Specific procedure (simplified) for the strategic analysis of technology resources in small manufacturing companies. *Source*: Adapted from Mantulak (2014).

In order to implement the procedure, it is recommended that a work team be set up, headed by an outside specialist,[1] and consisting of the entrepreneur and the plant foreman. While the specialist provides theoretical and methodological expertise, the entrepreneur offers a comprehensive overview of the business, particularly its technology resources, while the plant foreman furnishes hands-on knowledge and experience, and does not discard the possibility of including other employees as required.

Step 1: Assessment of technology resources

Along these lines, the definition of technology resources conceptualized by Morin (1992) will be taken into consideration, with the characterization and evaluation of the technology resources based on their classification as tangible (machinery, equipment, tools, instruments, and others) and intangible (individual and group knowledge, personal skills, corporate routines, in-house communications, and others). A list of possible Tangible Technology Resources will then be drawn up, together with a list of Intangible Technology Resources (Table 1), which may be casuistically adapted and tailored to the organizational conditions of each small manufacturing firm, and may also be used as part of the procedure.

In order to characterize and assess technology resources in small manufacturing firms, this procedure included drawing up the Technology Resources Assessment matrix shown in Figure 2, with the following empirical scale: Excellent (E), Very Good (VG), Good (G), Fair (F), and Poor (P), with the following associated scores of 5, 4, 3, 2, and 1, respectively. Thus, and similar to previous cases, the Technology Resource Importance is weighted casuistically, using the following scale: High (H), Medium (M), and Low (L), with the following associated scores of 5, 3, and 1, respectively.

Step 2: Definition of strategic technology resources

This step follows on from Step 1 of this procedure, using the Technology Resources Assessment (Figure 2) to specify which of them are rated as

Table 1. Technology resources to be categorized and evaluated in small manufacturing companies.

Technology resources—(tangible): TRT		Aspects for consideration
Process/Sector	Machines and crews	• Level of obsolescence • Conditions of use • State of conservation • Hygiene and safety conditions
	Tools	• Preventive and/or corrective maintenance • State of conservation • Type of use
	Building infrastructure, general layout of machinery and equipment	• Production process flow • Interferences between machines and equipment • Rational use of available space • Raw material handling and transport • Infrastructure functionality • Construction conditions of premises
	Solid waste storage	• Conditions of use • Location in terms of production process flow • Workplace safety and hygiene conditions
	Toolroom	• Conditions of use • Maintenance routines (preventive, corrective) • Workplace safety and hygiene conditions
Organizational	Individual and collective skills	• Workers with special skills • Workers with proactive attitudes • Skills that upgrade products
	Motivating organizational culture	• Global corporate development strategy • Employee retention • Corporate commitment to its employees • Employees feel they belong to the company • Proactive and motivating workplace atmosphere
	External relationships	• Links with customers, suppliers, vendors, and competitors • Relationship with institutions, associations, etc. • Analysis of ways of working among competitors • Market demands detection channels
Technical	Mastery of specific technologies	• Practices that lead to process upgrades • Modification of machines/equipment • Maintenance of machines, equipment, and tools
	Innovations	• Activities linked to product innovation • Activities linked to process innovation • Adaptation of existing technologies
	Technology data	• Technological surveillance of its environment • Benchmarking • Cooperation with other companies and organizations
	Safety and hygiene conditions/ good environmental practices	• Safe use of machines, equipment, and tools • Tidiness and cleanliness • Use of individual protection equipment • Deployment of accident prevention measures • Solid waste management • Correction of pollutive processes • Pollution prevention actions

Source: Prepared by the authors from Sáez de Viteri Arranz (2000); Hernández and Mirón (2002); Carrillo de Albornoz and Serra (2005); Esparza Aguilar, de Lema, and Guillamón (2010); Revilla (2012); and Mantulak (2014).

Tangible Technology Resources (TTR)		Rating					Importance		
		A (5)	VG (4)	G (3)	F (2)	P (1)	H (5)	M (3)	L (1)
Process/Sector	TTR_1								
	TTR_2								
	TTR_3								
	…								
	TTR_n								
Intangible Technology Resources (RT_{Ii})		Rating					Importance		
		A (5)	VG (4)	G (3)	F (2)	P (1)	H (5)	M (3)	L (1)
Organizational / technical	ITR_1								
	ITR_2								
	ITR_3								
	…								
	ITR_n								

Figure 2. Technology Resources Rating Matrix for small manufacturing companies (partial view). *Source*: Adapted from Mantulak (2014).

strategic in each case (tangible and intangible), namely: Tangible Strategic Technology Resources (TSTR) and Intangible Strategic Technology Resources (ISTR), whose importance is rated as High (H).

It is important to stress that the assessment encompasses tangible and intangible technology tools, doing so from the casuistic aspect of the importance that each company assigns to each of its resources. Therefore, classic classification techniques cannot be used for technology types (e.g., basic, emerging, and key).

On the other hand, it must be borne in mind that the procedure as a whole has been drawn up in a manner that allows it to be assimilated by the entrepreneur as well as by the foreman, which is why this step must also be easy to understand and simple to implement. It is thus intended that this tool will foster a teaching-learning process in the company, and can also be replicated by other business sector stakeholders.

Step 3: SWOT-TRD analysis

The purpose of this step is to link strategic technology resources to the strengths and weaknesses of the company as well as the opportunities and threats in its environment. This is done by using the SWOT (Strengths, Weaknesses, Opportunities, Threats) analysis technique, because this is a simple but powerful situation analysis tool. Within the framework of this research project, it was deemed appropriate and pertinent to conduct internal and external analyses of the company from a technological standpoint, which is why it was called a SWOT-TRD matrix, as it is technology resource-driven (Figure 5).

The following activities were required to construct the SWOT-TRD matrix:

1. Identify the internal factors of the businesses associated with Strengths (S) and Weaknesses (W), as well as external factors viewed as Opportunities (O) and Threats (TH), which could be described in detail and casuistically adapted.
2. List the tangible and intangible strategic technology resources obtained in Step 2 of this procedure.
3. List and evaluate the internal factors of the company through the results obtained in Activity 1, and through the internal factors assessment matrix (Figure 3), undertake their quantitative evaluation. Hence, it is suggested that the following empirical scale be used: Valuable (V), Significant (S), Normal (N), Somewhat Significant (SS), and Insignificant (In), with the following associated scores of 5, 4, 3, 2, and 1 respectively; the importance of each factor in the organization is then weighted, using the following scale: High (H), Medium (M), and Low (L), with the following associated scores of 5, 3, and 1, respectively. Next, forging ahead with this activity, the key factors in the organization are identified to define specific technological competencies, particularly those whose importance is rated as H, as the rating assigned to each factor in the evaluation identifies its current status, thus indicating whether requires adjustment; this evaluation is also a crucial preliminary stage in forecasting improvement activities and/or actions.
4. List and evaluate the external factors through the results obtained in Activity 1, and through the external factors assessment matrix of the sawmill (Figure 4), and undertake the quantitative evaluation of the links between the company and each factor. Thus, it is suggested that the following empirical scale be used: Very Significant (VS), Significant (S), Strong (St), Weak (W), and Non-Existent (NE), with the following associated scores of 5, 4, 3, 2, and 1, respectively; the importance assigned by the organization to each external factor is then weighted, using the following scale: High (H), Medium (M), and Low (L), with the following associated

	Internal factors	Rating					Importance		
		V (5)	S (4)	N (3)	SS (2)	In (1)	H (5)	M (3)	L (1)
Strengths	S_1								
	S_2								
	…								
	S_n								
Weaknesses	W_1								
	W_2								
	…								
	W_n								

Figure 3. Internal Factors Rating Matrix for small manufacturing companies (partial view). *Source*: Prepared by the authors.

	External factors	Rating					Importance		
		MS (5)	S (4)	F (3)	W (2)	In (1)	H (5)	M (3)	L (1)
Opportunities	O_1								
	O_2								
	…								
	O_n								
Threats	TH_1								
	TH_2								
	…								
	TH_n								

Figure 4. External factors rating matrix for small sawmills (partial view). *Source*: Prepared by the authors.

scores of 5, 3, and 1, respectively. The key influencing factors in the environment are then characterized, associated with the performance of the business, particularly those whose importance is rated as H, as the rating assigned to each factor in the evaluation identifies the strengths of its influence on the company, thus indicating whether this relation requires improvement.

5. Establish and code the lists of the following influences on key factors:
   - Key factors in the organization, distinguishing between Strengths (S) and Weaknesses (W), and coding them as KFs and KFw respectively;
   - Influencing factors in the environment, distinguishing between Opportunities (O) and Threats (TH), and coding them as IFO and IFTH respectively.
6. Construct a SWOT-TRD matrix for small sawmills (Figure 5) through links among strategic technology resources, key factors in the organization, and influencing factors in the environment, shown by an X in the cells where links are identified among them.

	Strategic technology resources	Key factors in the organization								Influencing factors in the environment							
		Strengths				Weaknesses				Opportunities				Threats			
		KFs_1	KFs_2	…	KFs_n	KFw_1	KFw_2	…	KFw_n	IFO_1	IFO_2	…	IFO_n	$IFTH_1$	$IFTH_2$	…	$IFTH_n$
Tangible	$TSTR_1$																
	$TSTR_2$																
	….																
	$TSTR_n$																
Intangible	$ISTR_1$																
	$ISTR_2$																
	…																
	$ISTR_n$																

Figure 5. SWOT-TRD matrix for small manufacturing companies (partial view). *Source*: Mantulak (2014).

7. Through the SWOT-TRD matrix, establish and code the following relationships on different lists: (a) between strategic technology resources and key factors in the company; and (b) between strategic technology resources and influencing factors in the environment.

Results

Case study

Case studies are particularly useful for analyzing the real-life business situations, in addition to offering a better understanding of the nature and complexity of related processes (Hernández, 2003; Viñas, 2000). Case studies pursue an analytical (nonstatistical) overview through applying logical inference to other cases with similar theoretical conditions (Monge, 2010). Thus, as a research strategy, they allow analysis, especially when the boundaries between the phenomenon and its context are not clear (Yin, 1981).

This research project explores the case study of a small sawmill in the Misiones Province of Argentina, through applying the described procedure in order to ascertain its feasibility and pertinence. This company belongs to a major market segment in Misiones, as 96% of logging businesses are ranked as small enterprises.

This company is engaged in the production of sawn and remanufactured goods from which items are obtained such as planed boards, tongue-and-groove boards, and cornices, with an output of around 200 m^3/month, while 92% of the sawmills have an output of up to 303 m^3/month. Often family-owned and run, their organizational structure is flattish (entrepreneur, foreman, and workers) with a headcount of around 10 permanent employees (79% of the timber businesses in Misiones employ up to 10 people).

Application of the procedure

Under a specific agreement signed by the company with the Engineering School, National Misiones University, a specialist is assigned to implement the application of the proposed procedure. Meetings with the entrepreneur outlined the actions needed to move ahead with the activities planned to analyze the technology resources.

Step 1: Evaluation of technology resources

Initially, the technology resources of the small sawmill are categorized, distinguishing between Tangible and Intangible Technology Resources, explored through an exhaustive assessment of the company's operating conditions.

Table 2. Tangible and intangible strategic technology resource ratings in a small sawmill and their status.

		Rating				
		A (5)	VG (4)	G (3)	F (2)	P (1)
Strategic technology resources (tangible): RTETi						
STTR1	Main circular saw			X		
STTR2	Chipper				X	
STTR 3	Anti-fungus dip system			X		
STTR 4	Moldings and tongue-and-groove board machine			X		
STTR 5	Toolroom			X		
STTR 6	Sharpening room			X		
STTR 7	Internal transport machinery and equipment				X	
STTR 8	Product loading and offloading machines		X			
STTR 9	Products storage system				X	
STTR 10	Tools and spares inventory			X		
Strategic Technology Resources (intangible): RTIi						
ISTR 01	Individual and collective knowledge and skills			X		
ISTR 02	Organizational routines				X	
ISTR 03	Internal communications			X		
ISTR T1	Master of specific technologies		X			
ISTR T2	Specific expertise in production processes			X		

Source: Prepared by the authors.

Step 2: Definition of strategic technology resources

Technology resources whose importance was rated as High in the assessment were tagged as strategic. As a result of this analysis, it became apparent that most of the Tangible and Intangible Strategic Technology Resources were ranked between Good (G) and Fair (F) (Table 2).

Step 3: SWOT-TRD analysis

Subsequently, the various internal factors of the sawmill were identified and evaluated, together with the external factors influencing it. Regarding the factors whose importance was rated as High, the corresponding key factors in the organization (Figure 6) were established through the identified Strengths and Weaknesses and as a result of the Opportunities and Threats the corresponding influencing factors in the environment (Figure 7).

Finally, based on relationships among the strategic technology resources, the key factors for the small sawmill and the influencing factors in their environments (Table 3), the SWOT-TRD matrix was constructed and, on this basis, the various links between:

1. Strategic technology resources (STR) and key factors in the organization:
   STR-Strengths: main circular saw, tongue-and-groove molding machine, sharpening sector, products storage system, organizational routines, internal communications and skills in production processes associated with the characterization of its products;
   STR-Weaknesses: main circular saw, chipper, blade sharpening section, organizational routines, internal communications associated with

Key factors in the organization		
Strengths	KFS_1	Direct sales to the domestic market
	KFS_2	Quality control of finished products
	KFS_3	Good reputation with customers
	KFS_4	Good quality products
	KFS_5	Direct contact with customers
Weaknesses	KFW_1	Shortfalls in workplace safety and hygiene
	KFW_2	StuVG ling blocks in work routine organization
	KFW_3	Few links with tiVG er industry institutions that offer consulting and advisory services on production, quality and other aspects.
	KFW_4	Problems resulting from the use of non-prime raw materials
	KFW_5	Generation of large amounts of wood wastes
	KFW_6	Generation of toxic sludge in the fungicide dip

Figure 6. Key factors in the organization. *Source*: Prepared by the authors.

shortfalls in workplace safety and hygiene, as well as work routine organization stumbling ling-blocks;

2. Strategic technology resources (STR) and influencing factors in the environment:

STR-Opportunities: main circular saw, tongue-and-groove molding machine, chipper, internal transportation equipment and machines, mastery of specific techniques and skills in production processes associated with better opportunities for products compliant with market quality requirements, possibilities of opening up new sales networks and accessing Regional and State tools fostering the enhancement of Small and Medium Enterprises;

Influencing factors in the environment		
Opportunities	F_{IO1}	Possibility of association with other sawmills
	F_{IO2}	Better opportunities for products compliant with quality requirements
	F_{IO3}	New paved access to Provincial Highway Nº 5
	F_{IO4}	Possibilities of opening new sales networks
	F_{IO5}	Possibilities of accessing nation-wide promotion tools for upgrading Small and Medium Enterprises (SMEs)
	F_{IO6}	Internet access
Threats	F_{IA1}	High electricity tariffs
	F_{IA2}	Difficult access to new production process technologies
	F_{IA3}	Lack of working capital credits
	F_{IA4}	Higher taxes imposed on this sector by the Province government
	F_{IA5}	Constraints on access to raw materials
	F_{IA6}	Lack of National and Provincial policies for the industrial forestry sector
	F_{IA7}	Competitors in the sector

Figure 7. Influencing factors in the environment. *Source*: Prepared by the authors.

Table 3. Analysis of SWOT-TRD matrix for small sawmill under study.

		Key factors in the organization											Influencing factors in the environment												
		Strengths					Weaknesses						Opportunities						Threats						
STR		KFS1	KFS2	KFS3	KFS4	KFS5	KFW1	KFW2	KFW3	KFW4	KFW5	KFW6	IFO1	IFO2	IFO3	IFO4	IFO5	IFO6	IFTH1	IFTH2	IFTH3	IFTH4	IFTH5	IFTH6	IFTH7
Tangible	TSTR1	X	X		X	X	X	X	X	X	X		X	X	X	X	X		X	X			X	X	X
	TSTR2	X					X	X		X	X				X	X	X		X	X				X	X
	TSTR3		X	X	X			X				X		X		X		X							
	TSTR4	X	X	X	X	X	X	X	X	X	X		X	X	X	X	X		X	X			X		X
	TSTR5		X		X									X				X		X					X
	TSTR6		X	X	X		X	X						X			X		X	X	X			X	X
	TSTR7	X					X	X					X							X	X			X	X
	TSTR8						X			X			X	X		X	X			X	X			X	X
	TSTR9	X	X		X			X	X	X													X	X	X
	TSTR10		X		X													X							
Intangible	ISTRO1		X		X									X											X
	ISTRO2		X		X	X	X	X	X	X	X	X		X		X			X				X		X
	ISTRO3		X		X	X		X				X	X			X							X		X
	ISTRT1		X	X	X		X							X			X								X
	ISTRT2		X	X	X		X	X	X		X			X		X	X								X

Source: Prepared by the authors.

STR-Threats: equipment and machines for production processes, imported organizational routines and internal communications associated with difficult access to new technologies for production processes, lack of Regional and State policies for the industrial forestry sector and competition with other small sawmills nearby.

The application of the procedure for defining strategic technology resources in a small sawmill initially assessed the value of the technological assets available in the company through identifying tangible and intangible technology resources, subsequently defining which of them were strategic for its technological development. Use of the SWOT-TRD matrix then allowed an integrated analysis of the company through links between strategic technology resources and key factors, in addition to characterizing its economic and social contexts through influencing factors. Finally, this allowed the underlying status of the company to be defined, underpinning the design of development strategies for this small sawmill.

Conclusions

It is vital to assign strategic status to technology resources in the functional structure of small manufacturing companies, as they form the cornerstone underpinning development strategies for these types of businesses, which is why it is crucial to define the available technological assets right from the start through an integrated analysis of corporate assets and links and relationships with specific and generic environments, in order to ensure the best possible use for the business.

This procedure consisted of a simple methodological tool for technology management in small manufacturing companies that provides a comprehensive overview of the relationships between the various aspects and components of the organization and its environment, systematically constituting an important input for designing the business development strategy of each enterprise.

The application of the developed procedure to a small manufacturing company underpins the feasibility of blending theoretical concepts with the hands-on daily routines of the business, through the real-time identification and appraisal of its Tangible and Intangible Technology Resources, constituting a tool providing input for strategic decisions taken by the business owner/entrepreneur.

This research project helped firm up stronger links and technology transfers between the University and the local business sector through systematic and synergetic joint efforts. As a result of these accomplishments, it would be timely for future research projects to analyze the contribution made by implementing the procedure to more effective deployment of the technological competencies of this type of companies, examined through appropriate and pertinent technology management indicators.

Note

1. The participation of such specialists may be financed by the company itself or through small and medium size enterprise upgrade financing and promotion tools available in their own countries.

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