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# TERRITORIAL TECHNOLOGICAL CAPABILITY: CONCEPT, MODEL AND APPLICATIONS
# CAPACIDADE TECNOLÓGICA TERRITORIAL: CONCEITO, MODELO E APLICAÇÕES

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## Abstract

The notion of territory has been increasingly used to define spaces in order to allow analysis focused on the study of local development. Although this concept is still under construction, it seems obvious that a territory is defined not only by its natural conditions, but also by its economic, social and cultural aspects. Assuming this assertion, this study considers that territories have a set of natural and built characteristics that stimulate or hinder the generation, absorption and usage of technology by their agents. Thus, the technological development in a territory wouldn't depend only on the entrepreneurial actions of its socioeconomic agents, but also on preexisting conditions on the territories where they act. In order to press forward in this discussion, this paper proposes the concept of territorial technological capability (TTC) and presents an analytical model capable of measuring it. The article conducts a literature review on territories, territorial development and technological capability that supports the proposed concept and model. In fact, knowing the technological capability of the territories can provide relevant support for establishing public and private policies that stimulate the creation, transfer and adoption of technological innovations geared towards territorial development. The concept developed opens the possibility to approach the technological development of territories from a new analytical perspective.

**Keywords:** territorial technological capability; territorial development; technological innovation; technological capability.

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## Resumo

A noção de território tem sido cada vez mais utilizada para definir espaços de forma a permitir análises centradas no estudo do desenvolvimento local. Embora este conceito ainda esteja em construção, parece óbvio que um território se define não só por suas condições naturais, mas também por seus aspectos econômicos, sociais e culturais. Partindo dessa assertiva, este estudo considera que os territórios possuem um conjunto de características naturais e construídas que estimulam ou dificultam a geração, absorção e utilização da tecnologia por seus agentes. Assim, o desenvolvimento tecnológico em um território não dependeria apenas da ação empreendedora de seus agentes socioeconômicos, mas também das condições preexistentes nos territórios onde atuam. Para avançar nessa discussão, este artigo propõe o conceito de capacidade tecnológica territorial (CTT) e apresenta um modelo analítico capaz de medi-la. O artigo faz uma revisão da literatura sobre territórios, desenvolvimento territorial e capacidade tecnológica que sustenta o conceito e modelo propostos. De fato, conhecer a capacidade tecnológica dos territórios pode fornecer subsídios relevantes para o estabelecimento de políticas públicas e privadas que estimulem a criação, transferência e adoção de inovações tecnológicas voltadas para o desenvolvimento territorial. O conceito desenvolvido abre a possibilidade de abordar o desenvolvimento tecnológico dos territórios a partir de uma nova perspectiva analítica.

**Palavras-chave:** capacidade tecnológica territorial; desenvolvimento territorial; inovação tecnológica; capacidade tecnológica.

## INTRODUCTION

Territories are high analytical complexity environments. However, the difficulties brought about by this complexity do not diminish the importance of carrying out research that highlights the territorial component as a relevant explanatory variable for the technological development dynamics of countries and regions. From the point of view of its capability to explain and favor technological innovation, an analysis in territorial terms must consider the dimensions and nature of historical, environmental, technical-production, cultural, social, economic, edaphoclimatic and political scope. Complex means of spatial proximity analysis have been approached by the literature, however, there is still room for studies that simultaneously consider the role of different proximity types, their synergies and complementarities (CAPELLO; CARAGLIU, 2018).

Factors such as soil, topography, hydrography, climate, energy sources, among others, are not sufficient to explain innovation and the greater or lesser competitiveness of production sectors of a given territory. In addition, a given "built territorial identity" must be added to the physical factors, which can facilitate a successful articulation between the natural factors of the territory and the technologies employed in its production sectors.

Thus, the challenge of developing an analytic model where institutions play a broader role on the innovation process should consider that a given territory has natural and built, tangible and intangible characteristics that favor or impair technological development. The set and interaction of these characteristics are responsible for the technological capability of a given territory. From this point of view, it is important to develop analytical models to analyze the ability of territories to generate, disseminate, adapt and incorporate technological innovations that can contribute to their own development. In order to move in this direction, this paper presents the concept of territorial technological capability and proposes an analytical model capable of evaluating it.

## Innovation, development and territory

Innovation plays a prominent role in regional development strategies (ACS et al., 2016; ARBO; BENNEWORTH, 2007; CAIAZZA; RICHARRDSON; AUDRETSCH, 2015; CLAUSEN; KORNELIUSSEN, 2012; FELDMAN, 1993; MACKINNON; CUMBERS; CHAPMAN, 2002). At the same time, innovation capacity is influenced by factors which are not homogeneously distributed between territories (FELDMAN; AUDRETSCH, 1996).

For Lima, Simões and Monte-Mór (2014), alongside technologies and institutions, territories are essential elements for the dynamism of economic projects. Regional economic development is the cause and effect of a set of actions with a greater or lesser degree of integration that leads the actors in a region to acquire sufficient innovation capability in order to influence the economic, social, technological dynamics and quality of life of its citizens. Thus, the technological and economic level of a territory is closely related to its ability to develop scientific and technological research and generate solutions to its technical, economic and social problems (CLAUSEN; KORNELIUSSEN, 2012).

Arbo and Benneworth (2007) also consider that economic development and productivity growth depend on innovation and bring important territorial consequences. For these authors, the progress of certain regions depends on their ability to develop and exploit innovation in their environments. The importance of certain aspects related to the local communities, such as institutionalities and knowledge spillovers, should be emphasized when they are present in certain territories, which can make the regions more attractive, hence constituting a competitive advantage (ACS et al., 2016; FELDMAN; AUDRETSCH, 1996; CAIAZZA; RICHARRDSON; AUDRETSCH, 2015; FELDMAN,

1993; RODRÍGUEZ-POSE, 2013; SCOTT, 1996). Thus, local initiatives can play a fundamental role in development, becoming a factor of competitiveness and transforming territories into innovative environments (VEIGA, 2002).

Frequently, territorial identity (BENATI et al., 2018) is seen as the cause and consequence of a given technological, economic and social development stage. Lima, Simões and Monte-Mór (2014) point out that territorial space plays an active role in the origin of social relations, establishing specific and characteristic modes of production of the society that inhabits this space. Albagli (2004) establishes four central points of view to the concept of territory: the physical, the political/organizational, the economic and the cultural/symbolic elements. The many features cited in these approaches are presented in Table 1.

**Table 1** - Dimensions and correlated conceptions addressed in the territorial concepts.

| DIMENSION | OBSERVED ASPECTS | AUTHOR |
|---|---|---|
| Economic-production | ➢ Regional identity;<br>➢ Economic;<br>➢ Technical; Production;<br>➢ Meso and micro-regions (economic axes);<br>➢ Local spaces (technical). | Albagli (2004); Santos (2006); França (2013). |
| Sociocultural | ➢ Power relations between groups;<br>➢ Appropriation of space;<br>➢ Power action;<br>➢ Regional identity;<br>➢ Interaction and social process;<br>➢ Cultural. | Abramovay, Magalhães and Schoroder (2010); Albagli (2004); Favareto (2010); Jeziorny (2015). |
| Physiographic | ➢ Conflict: local X regional\national;<br>➢ Meso and micro-regions (Social process);<br>➢ Political organization;<br>➢ Political-economic actions;<br>➢ Physical-geographic;<br>➢ Regional identity;<br>➢ Appropriation of space | Albagli (2004); Schneider and Tartaruga (2004); Arbo and Benneworth (2007); Haesbaert and Limonad (2007); Bebbington et al. (2008); Abramovay, Magalhães and Schoroder (2010); Favareto (2010); França (2013). |
| Institutional | ➢ Social construction;<br>➢ Institutional architecture;<br>➢ Historical construction;<br>➢ Regional identity;<br>➢ Institutional. | Santos (2006); Favareto (2010); Haesbaert and Limonad (2007); Freitas, Freitas and Dias (2012); Lehmann and Seitz (2017). |

Source: prepared by the authors

In some theoretical approaches, the characteristics, the proximity, the levels of consensus and the trust socioeconomic actors establish among themselves, are defining factors of territorial identity. Thus, a territory cannot be understood separately from its economic, political, and social dimensions

that influence the social processes that are developed within (BEBBINGTON et al., 2008; JEZIORNY, 2015). In some theoretical approaches, the characteristics, the proximity, the levels of consensus and the trust that socioeconomic actors establish among themselves, are defining factors of territorial identity.

In the context of this paper, territory is defined as a geographically defined area characterized by the interactions between physical-environmental, socio-cultural, political-administrative and economic-production dimensions. These dimensions are configured subjectively, forming awareness and expressing territorial identity, or objectively, by the results of political-economic and governmental actions. The interactions of these dimensions determine distinct territorial dynamics which will consequently require different technological development policies.

## Territorial development

In a way, the emergence of the terms “spatial development” and “territorial development” resulted from pressures over the planning apparatus to redefine its missions. (VEIGA, 2002). In the 1970s, economic approaches began to emerge from Schumpterian tendencies that identified the territory as an important element in technological development.

The broader approaches go on to consider the importance of institutionality (AMIN, 2002; CLARK; HUANG; WALSH, 2010; DIAS, 2013; HERVÁSÓLIVER; ALBORS-GARRIGÓS, 2007) and historic process (CORRÊA et al., 2019) in territorial development processes. In this same direction, Maillat (2002) approaches the innovative means of the institutionalist view, that is, norms, values and routines that guide the behaviors and relations between the actors, assuring the functioning of the production systems (LEHMAN; SEITZ, 2017; RODRÍGUEZ-POSE, 2013). Rallet (2002), however, sees the innovative means as an economic conception and not only as an institutional configuration.

Granovetter (1985), in the context of what he calls “social immersion,” considers that economic actions are influenced by social relations. In fact, institutional arrangements are important to create and maintain the agglomerations of actors that influence and are influenced by local development. The synergy of the local actors can provide, among other results, an increase in the capability of innovation, allowing local survival in face of the global economy (LIMA, SIMÕES; MONTE-MÓR, 2015). Thus, this synergy is influenced by the geographical and relational proximity of local actors (DIAS, 2013; RALLET, 2002).

Favareto (2010) believes that the development of territories results from the convergent coordination of private and social benefits, that is, a way of organizing the production and distribution of individual goods in such a way that it ensures the distribution of collective gains in a reasonable manner. The "market interdependencies", described by Storper and Scott (1995) as factors that transform the territory into economic resources, and "non-market interdependencies," can generate specific resources in different territories (DIAS, 2013).

Aspects related to institutionality create a somewhat differentiated territory in the economic environment, being able to generate a competitive advantage over other territories or economic agglomerations (FELDMN, 1993). In order to observe the differences of each territorial environment, Dias (2013) point out that past habits, routines, knowledge, cognitive capability, intersubjective relations, corporate power, political regulations and public policies should be taken into account. This is what Hayter (2004) describes as the social economy of the territory, which helps foster the concept of territorial development.

A few authors have been utilizing the resources-based vision (RBV) to explain performance aspects of productive agglomerations (HERVÁS-OLIVER; ALBORS-GARRIGÓS, 2007). Some aspects of this approach are in line with the one taken by this paper. However, in contrast to what is proposed by those authors, this paper starts from territorial space to comprehend clusters or productive agglomerates, thus taking an analytical-prospective vision, instead of an analytical-explanatory one.

Finally, it can be said that the territorial development process must be multidisciplinary and intersectorial. Its success depends on valuing its endogenous characteristics and utilizing its exogenous opportunities, in order to have competition with cooperation, valorization of the conflict with the collective participation of the actors and use of local knowledge together with the scientific knowledge outside the territory.

## Technological capability

The literature is abundant with studies aimed at analyzing the technological capability of companies or production sectors (COHEN; LEVINTHAL, 1990; BABINOT; MARQUES, 2009; FIGUEIREDO, 2005; LALL, 1992; MOHAMMADI; ELYASI; KIASARI, 2014).

Initially, studies of technological capability have been directed to the improvement of technical-production capacities and the use of knowledge to improve the firms' technical-economic performance. These studies then advanced in an attempt to understand the organizational dimension of technological capability (ARAÚJO, 2005). For Mohammadi, Elyasi and Kiasari (2014), the concept of technological capability is still controversial being subject to usage in different contexts and referring to the existence of a certain entrepreneurial ability to manipulate the different aspects (physical or not) involved in the production process.

Balbinot and Marques (2009), Cohen and Levinthal (1990) and Lall (1992) argue that the built technological capability is defined by the ability of companies to evaluate, exploit and use external knowledge. Lall (1992, 66) defines a company's technological capability "as a continuous process of absorption or creation of technical knowledge, partly determined by external factors and partly by the internal accumulation of knowledge and skills".

Ben (2005), referring to the works of Bell, Lall and Pavitt, sees technological competences as synonymous with technological capability. These competences are the necessary resources to generate and manage improvements in production, project engineering and investments Shikida, Azevedo and Vian (2011) address the set of competences which translate technological capability into the company's competitiveness.

While admitting the lack of a consensus regarding the concept of technological capability found in the literature, Mori, Batalha and Alfranca (2014) define it as being the company's capability to use, adapt, generate, develop, transfer and diffuse technologies. It would be the result of a set of effort, skills (operational, organizational, relational and learning) and information paramount for the solid incorporation of innovations in organization's operations.

For Araújo (2005) and Hueske (2015), in addition to internal technological capabilities, other variables may affect the company's technical-economic performance, such as technological learning processes, external crises and macroeconomic or sectoral measures. A comprehensive approach to technological capability in companies goes beyond its conventional elements, such as technical-physical systems and human capital, in order to capture the organizational dimension of technological capability.

Table 2 summarizes some of the concepts related to business technological capability available in the literature.

**Table 2** - Concepts of technological capability

| Concepts of technological capability | Author | Year |
|---|---|---|
| Capability related to knowledge efforts to improve the production capability of the company. | Katz* | 1976 |
| Local capability to absorb, adapt and modify technologies that are transferred. | Kharbanda and Jain* | 1977 |
| Capability to manage technology during the implementation of technical changes. | Bell* | 1984 |
| Capability developed to evaluate, explore and use external knowledge. | Cohen and Levinthal | 1990 |
| Absorption/creation process of technical knowledge, determined by external factors and by the accumulation of knowledge and skills. | Lall | 1992 |
| Resources needed to generate and manage improvements in production, project engineering and investments. | Ben | 2005 |
| Capability to use the knowledge and its reflexes in the technical-economic performance of the company. | Araújo | 2005 |
| Knowledge base and specific assets of the companies, used as source of performance differentiation in the same industrial sector. | Figueiredo | 2005 |
| Set of functional skills that impact the performance of the company and whose ultimate purpose is to manage "generating value". | Balbino and Marques | 2009 |
| Knowledge resources needed to generate and manage the company's technological change. | Miranda and Figueiredo | 2010 |
| A set of skills that translates the company's competitiveness. | Shikida, Azevedo and Vian | 2011 |
| The company's capability to use, adapt, generate, develop, transfer and diffuse technologies. | Mori, Batalha and Alfranca | 2014 |

*Apud Balbinot and Marques (2009)

Source: adapted by the authors based on Balbinot and Marques (2009)

The compilation of the factors that define the concept of technological capability in the works of the various consulted authors allows identifying the dimensions and elements that characterize a given technological capability. (see Table 3).

**Table 3** - Dimensions and elements of technological capability

| | DIMENSIONS | ELEMENTS |
|---|---|---|
| **TECHNOLOGICAL CAPABILITY** | **Technical-economical** | • Business Infrastructure and technical assistance;<br>• Technical-physical systems;<br>• Technical-production and economic system;<br>• Production management. |
| | **Institutional** | • Availability of investments;<br>• Infrastructure and management of R&D<br>• Public policy and Education<br>• Relationship between companies. |
| | **Organizational** | • Technological learning;<br>• Organizational learning and management;<br>• Human capital;<br>• Technological effort. |

Source: prepared by the authors

Technological capability has become an important aspect to be analyzed by firms looking for growth and survival in an increasingly competitive environment. The concept of technological capability has expanded its scope and now encompasses functional elements internal to the companies, while also incorporating aspects related to the environments in which they are inserted. It is in this context that the territorial technological capability concept gain importance.

## Evaluation models of technological capability

Mohammadi, Elyasi and Kiasari (2014) state that assessing technological capability is vital in defining companies' technological strategies. At the same time, technological capability indices are useful for making decisions in terms of technology and innovation management within sectors of the economy. In a different analytical segment, indices can be used to assess a given level of regional innovation, as well as to identify and evaluate factors which would contribute or hinder a desired innovation level for a given territory. That being said, the notion of technological capability can be observed and applied to organizations but also in sectors and industries.

There are different ways to evaluate companies' technological capabilities. Figueiredo (2005) developed an evaluation metric that allows ranking of the functions of technological capability. He believes technological capability develops in successive stages which would allow identifying and measuring the accumulation of technological capability of a company through time. In line with this reasoning, a few researchers argue that intermediate levels of technological capability can act as prerequisites or are necessary for attaining higher levels of technological knowledge (MIRANDA; FIGUEIREDO, 2010).

Lall (1992) developed an evaluation matrix where the technical functions (investment, production) and its sub-items (project execution, project engineering, etc.) are related to the complexity or stage of the firm's technological capability (basic, intermediate and advanced). In turn, Mohammadi, Elyasi and Kiasari (2014) define three levels of technological capability: strategic, tactical and supplementary.

The capability building mode depends on the nature of the technology (whether process or serial, simple or complex, large or small scale), as well as on external factors of the firm that exert great influence on its technological capability acquisition process (LALL, 1992).

Measuring companies' technological capability is often related to the level of R&D spending, to the qualification of their human resources, to the possession of patents or to the number of scientific papers published by their collaborators. These indicators do not directly comprise the aspects of institutional and organizational environments where this technological capability was generated and developed.

In general, it can be said that the works of Araújo (2005), Figueiredo (2005), Lall (1992), Miranda and Figueiredo (2010), Mohammadi, Elyasi and Kiasari (2014) and , Shikida, Azevedo and Vian (2011) suggest ways of capturing and analyzing technological capability in companies from different production segments. They generally seek to understand the technological dynamics of companies and sectors to indicate strategies for successful technological development. Analogously, this is the same logic that guides the proposition of a concept and a model for technological evaluation of territories.

In fact, similar territories in terms of technological capabilities measured only by conventional indicators, with objective and quantitative characteristics such as R&D investments, number of patents, level of infrastructure, etc., can attain diverse territorial development degrees. The model proposed in this paper goes beyond these characteristics and also considers other more comprehensive aspects in the evaluation of technological capability in the territory.

## Concept and proposal of model for Territorial Technological Capability (TTC)

Technological innovation is an important driving force in the development of territories. Nevertheless, territories have characteristics that differentiate them from each other and that condition and are conditioned by technological capabilities. As with companies, these characteristics do not refer only to physical dimensions such as production infrastructure and R&D, but also to more intangible features, such as social capital and cultural identity. The proposed model assumes these premises.

The Territorial Technological Capability must reflect aspects related to the dimensions that characterize the singularity of each territory, whether given (natural) or constructed. Therefore, the TTC can be defined as the existing capability in the territory to use, adapt, generate, disseminate and transfer technology through its technical and production systems, technological learning and production infrastructure, backed by the synergies of their economic, social and institutional characteristics, directed to territorial development.

Bringing together the existing dimensions in the approach to business technology and territorial technology facilitates the establishment of the concept of territorial technological capability. Just like the companies need dynamic capacities to innovate, aggregating internal and external knowledge seeking competitive advantage (CAIAZZA; RICHARDSON; AUDRETSCH, 2015), territories must also mobilize their resources to promote innovation on their social and economic agents, analogously. The conceptualization proposed in this article opens the way for structuring and proposing a model for the measurement and analysis of this new concept.

The proposed territorial technological capability measurement model uses two variable groups that have different origins, which were discussed in previous sections. The first starts in the dimensions that characterize the territory. The second group concerns the dimensions that characterize the technological capability in companies. From the analysis of the concepts of territory and technological capability in companies, with its dimensions and elements, the TTC concept can be established. The four dimensions in the TTC concept are technical-economic-production dimension, socio-organizational dimension, institutional dimension and political-administrative dimension (See Figure 1).

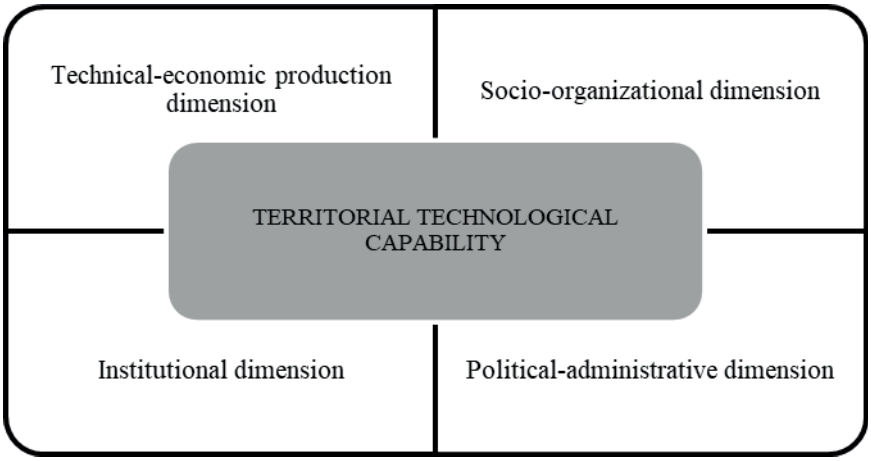


**Figure 1**. The dimensions of territorial technological capability
Source: prepared by the authors

The proposed analytical model includes the analysis of the main aspects of the territorial technological capability concept, which involves the use, adaptation, generation and transfer of technology. Each dimension is composed of several elements that characterize it, each element being defined as an indicator (descriptors) to compose the index of territorial technological capability stage (Table 4).

**Table 4** - Descriptors related to the dimensions and elements of the TTC.

| DIMENSION | ELEMENT | DESCRIPTORS |
|---|---|---|
| **Technical-economic-production** | Technical-production system of the territory | Machines and equipment for the production of goods and services. |
| | | Use of technologies for the production of goods and services. |
| | | Information technology (IT) systems for production. |
| | | Industrial park installed |
| | Technological dynamics of the territory | Origin of the technology used. |
| | | Public and private actors involved in the technological flow. |
| | | Process of capture and internalization of technologies (external events of technology transfer). |
| | | Access to technical content via the web. |
| | | Conducting internal technology diffusion events. |
| | Technical assistance | Infrastructure of technical assistance (buildings, vehicles and equipment) to promote technological dynamics in the territory. |
| | | Human capital (technicians) with training and updating required to implement and/or generate technology. |
| | | Flow of information with R&D to absorb, adapt or generate technologies. |
| | Production Infrastructure of the territory | Road system of the territory and with external connection (roads, ports, railways, waterways). |
| | | Transportation fleet (trucks, ships, trains). |
| | | Transport, energy and communication infrastructure. |
| | | Energy sources available in the territory. |
| | Internal and external market of the territory | Existence and access to internal market for production - market, business to business, retail or wholesale niches. |
| | | Existence and access to internal market for the acquisition of inputs for implementing/generating technologies. |
| | | Existence and access to external market for production - market, business to business, retail or wholesale niches. |
| | | Existence and access to external market for the acquisition of inputs for implementing/generating technologies. |
| | Physiographic characteristics for production | Characteristics of soil, topography, climate, hydrography, fauna and flora that favor or impede the implementation of the technology. |

Source: prepared by the authors

**Table 4** - Descriptors related to the dimensions and elements of the Territorial Technological Capability (continuation).

| DIMENSION | ELEMENT | DESCRIPTOR |
|---|---|---|
| **Socio-organizational** | Technological learning in the territory | Level of training workers (medium, technological, higher or post-graduate). |
| | | Courses and training flows and/or professional updating. |
| | | Vocational training systems - offering courses. |
| | Organizational management | System/service to support business management or consultancies. |
| | | Coordination of supply chains (governance structures). |
| | | Use of IT systems for business management. |
| | Human capital in the territory | Non-technological educational system (elementary and secondary). |
| | | Infrastructure, resources and equipment of the local educational system. |
| | | Capacitating teachers of the educational system. |
| | Relationship between companies | Collaboration and integration between supply chain companies. |
| | | Trust between supply chain companies. |
| | | Information sharing between companies. |
| **Institutional** | Availability of capital | Public and private resources applied to territorial development. |
| | Infrastructure and management of R&D, S&T and TT | Public and private organizations of R&D, S&T and TT. |
| | | Projects with resources for R&D and TT. |
| | | Infrastructure and resources for public or private technical assistance. |
| | Public policies | Public policies (proposals and application) aimed at the territory. |
| | Basic and fundamental Education | Plans and actions aimed at Basic and Fundamental Education. |
| | Historical-cultural trajectory of communities | Cultural manifestations, formation and trajectory of the community, religious insertion, communication and relevant ethnic factors. |
| | | Ethnic and religious factors that facilitate or hinder innovation. |
| **Political-administrative** | Political-administrative division | Political-administrative composition of the territory. |
| | | Formal recognition of territory. |
| | Legal planning | Legal framework (federal, state, municipal) to stimulate the production and occupation of the territory. |
| | | Specific territorial planning. |
| | Government Actors | Presence of State organizations and their performance in the technological dynamics (innovation). |
| | | Capacitation of state agents. |
| | Non-Government Actors (NGO) | Presence of NGOs (local or external) active in the technological dynamics (innovation). |
| | | Linking NGOs to external sources and institutes. |
| | | Individual actors relevant to the technological dynamics. |

Source: prepared by the authors

In order to obtain data and capture each descriptors' features, the elaboration of a survey following propositions by Voss, Tskriktsis and Frohlich (2002) is suggested. The survey elaborated based on each dimension's own descriptors represents the variables of the proposed model. Each descriptor generates, at least, one question. Questions must be answered according to a Likert scale in order to try and capture the subjective reality of multiple sources of information. To answer the survey, key-individuals who are part of the processes which support innovation on the territory must be selected, based on Possas, Salles-Filho and Silveira (1994).

The value of the result achieved grants the model significant adherence to the local context and reality once they are obtained with information on the social and economic actors present on the territories. The qualitative dimension relates to the nature of regional and local development, with the qualitative approaches focusing on subjective questions intertwined by local and regional development principles and values, socially determined in the particular context of specific locations and regions (PIKE; RODRÍGUEZ-POSE; TOMANEY, 2007).

The analysis of the dimensions proposed by the model, through the evaluation of its descriptors, allows classifying one territory in four levels of technological capability progress. These levels can be visualized in the matrix form shown in Figure 2.

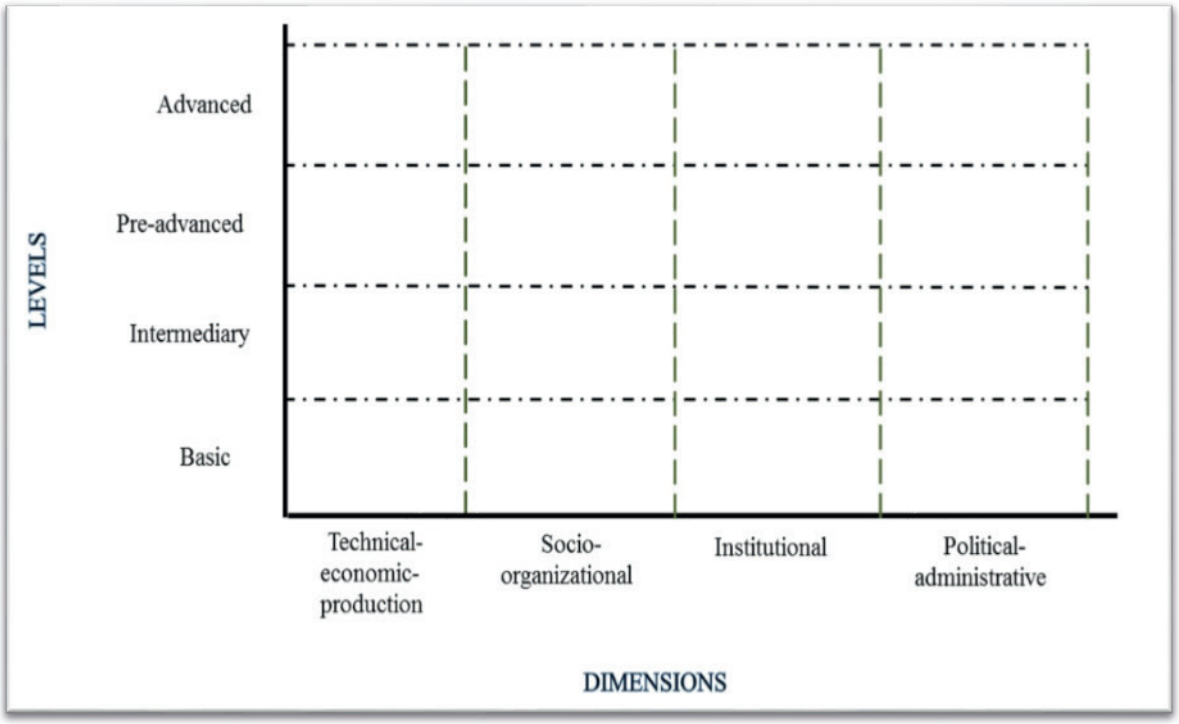


Figure 2: Model to Measure Territorial Technological Capability
Source: prepared by the authors

The binary idea of being innovative or not is limiting. It is better understood when it verifies to what degree or stage it is in relation to the technological capability (MIRANDA; FIGUEIREDO, 2010). Thus, the proposed model points out a continuous trajectory of the TTC level for each dimension independently of each other. In the same way, each descriptor can maintain an independent behavior within each dimension.

The proposal of a TTC model is inserted in the perspective of understanding the exact moment the technological dynamics of a given territory is in, in relation to a given technology. Based on the analysis allowed by the proposed model, the goal is to capture the current moment of the territory in relation to a certain technology or set of technologies inserted in a production system, allowing a prospective analysis of actions which will suppress limitations of technological development. The analysis of TTC, as presented in this paper, aims to assess which and how local preexisting conditions influence the success of an innovation in a given territory. Thus, there is a difference between the TTC notion presented in this paper and the innovation capacity commonly presented in the literature (HAMIDI; ZANDIATASHBAR; BONAKDAR, 2019). The analytical model proposed in the paper evaluates which factors would be important for a technology to succeed in a given territory. This identification is paramount in establishing public and private policies to act on these factors aiming to enhance the odds of success. It is, ultimately, an *ex ante* evaluation of the success of an innovation on a territory. On the other hand, a significant amount of the analysis relating territory and innovation perform *ex post* evaluations of the innovation's introduction.

The four levels that classify the technological capability of the territory in a different way are described below:

**Basic Level** ➔ The territory is capable of using and disseminating exogenous technology internally, through existing mechanisms recognized by local agents.

**Intermediary Level** ➔ The territory has the capability to adapt exogenous technology and diffuse it between the agents of the local productive system.

**Pre-advanced Level** ➔ The territory has installed capability to generate, validate and diffuse endogenous technology in the territory itself.

**Advanced Level** ➔ The territory has the competence to transfer technology (know-how) generated in the territory to other territories or productive environments.

## Concluding remarks

Technological innovations are important elements for the development of companies and territories. However, the study of development under a territorial perspective broadens the traditional approaches in terms of the economic sector. There is no doubt that the ability to use technologies to improve and intensify social relations, rather than replacing them, is an important step towards strengthening territoriality and competitiveness

The concepts about territories are complex and are composed of observation and analysis of the different dimensions, that include social, environmental, economic-productive, political, institutional and organizational aspects, and others. On the other hand, the dimensions and descriptors of technological capability, are usually associated with and restricted to a business analysis perspective. Thus, the transposition of the technological capability concept into a space for analysis that is located in a territorial level, that is, beyond that of the companies, requires considerable reflection effort.

In proposing this transposition, the concept of territorial technological capability, presented in this work, brings a new approach to technological development associated with the characteristics of the territories. Different territorial aspects expressed and described in its dimensions and elements are recognized and incorporated. This allows a broader analysis of technological capability, which goes beyond the indicators of technological capability normally used by companies and sectors. The proposal of a territorial technological capability model is inserted in the perspective for understanding at which moment the technological dynamics of a given territory is in, with regard to a specific technology.

The proposed analytical model seeks to operationalize the concept of territorial technological capability. It allows the investigation and identification of uncharacteristic territorial features that can promote or hinder one innovation in a given territory. Therefore, the analysis of territorial technological capability has the potential to support the successful implementation, adaptation and generation of technologies, offering a prospective analysis of the limitations and strengths present to expand technological dynamics.

The TTC proposition recognizes and partakes of works and studies regarding geography of innovation, even though it proposes an approach aiming to know the capacity to innovate of a

territory or region. The TTC analysis may contain the knowledge spillovers, although it is not its intention to identify or measure them. The ultimate goal is to get to know the capacity those socio productive environments have to adopt technologies and, with that, contribute to technology transfer politics.

In addition to evaluating the technological capability stage of a particular technology or set of technologies (or production system) in a territory, the proposed model envisions the possibility of other applications such as:

1) Identify aspects of intervention for technology transfer with a focus on innovation.
2) Compare the level of technological capability between different technologies in a territory.
3) Compare the level of technological capability of a given technology in different territories.
4) Evaluate the technological capability progress of a territory for a given technology or production system from successive applications of the model.
5) Promote the definition and application of public policies for the production sector of the territory or of a region.
6) Support the evaluation of implementing public policies and private technological innovation programs.
7) Adapt the data collection instrument for its application in a more quantitative sample.
8) Adapt the data collection instrument to capture the potential for existing technological capabilities.

The possibility to obtain individual results for the dimensions and descriptors of the proposed model allow identification and attribution of priority to actions to stimulate the technological capability in the territories. Because it is a concept that has a broad and flexible approach, the limits of the territory where the concept and model will be applied can be defined according to diverse interests.

Finally, it is important to observe that this paper intends neither to exhaust the subject nor to deliver a finished concept or analytical model. The fact that the model adopts a theoretical approach which is multifaceted and transversal to various field of knowledge brings the advantage of a holistic multisubject vision, along with the obvious disadvantage of having to gain depth in a few of the main points of the ideas presented. It is, therefore, a first reflection proposal which can and should be enrichened with future works.

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