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# About the Roles of TVET in the Brazilian System of Innovation

## A Critical Discourse Analysis on TVET Modernization in Brazil

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**Abstract** *This paper employs Critical Discourse Analysis (CDA) to investigate the discourses on modernization of Technical and Vocational Education and Training (TVET) in Brazil and its integration into the national innovation system. Two key aspects are explored: (1) how the roles of TVET organizations are represented in the innovation and TVET discourses in Brazil, and (2) how the roles of TVET graduates in innovation processes are represented in the innovation and TVET discourses in Brazil. The research framework draws from Cultural Political Economy (CPE) and the Critical Discourse Analysis. The analysis, based on the CDA approach of Fairclough & Fairclough (2011, 2012) is presented around three main layers: Discursive Practices, Discourses as Texts, and Discourse as Social Practices. Data collection methods encompass document analysis and interviews with experts in Brazil. The study finds that SENAI and the Federal Network advocate a radical approach, aiming to boost TVET's role in Brazil's innovation model, while SENAC takes a conservative stance, limiting the involvement of TVET institutions and graduates in innovation.*

**Title** *About the roles of TVET in the Brazilian System of Innovation. A Critical Discourse Analysis on TVET Modernization in Brazil*

**Keywords** *Innovation, systems of innovation, TVET, vocational education, TVET modernization*

## 1 Introduction

In the 21st century, Technical and Vocational Education and Training (TVET) systems worldwide are undergoing significant transformations. In an era characterized by economic discourses that underscore the pivotal role of innovation-led productivity

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as the main driver for sustainable growth and development. The notion of innovation as the driver of economic progress, and by extension, societal well-being, has gained widespread acceptance. This pervasive belief in an innovation imperative (OECD, 2015) provides the foundation upon which public and private actors focus their attention, devising diverse strategies and policies aimed at enhancing their innovative capabilities.

Globally, a consensus seems to prevail that a region's or country's innovative capacity is contingent upon the interactions among diverse actors within a well-coordinated system. This principle underlies the concept of systems of innovation, supported by organizations such as the OECD and embraced as a pivotal policy framework in recent decades worldwide. A system of innovation can be construed as "a system of interconnected institutions to create, store, and transfer the knowledge, skills, and artefacts which define new technologies" (Metcalfe, 1995, p. 462) or other types of innovations. The development of systems of innovation, wherein knowledge and skills circulate among different stakeholders, has assumed important significance on the economic policy landscape. It functions as a centripetal force influencing societal perceptions and shaping education policies.

As the 'innovation imperative' highlights the importance of education and training as integral components of the innovation processes, global, national, and local discourses on TVET recurrently invoke the term 'TVET modernization' to address the process of adapting, transforming, or reforming existing TVET systems to align them with a desired future state, wherein TVET systems are more seamlessly integrated into systems of innovation and more attuned to economic needs. However, the integration of 'modern' TVET in innovation policies can also represent until certain level a source of transformation of local and national vocational education cultures. This occurs not only because innovation policies seek to integrate TVET, but also because the different TVET systems, networks, and schools are incorporating the discourse on innovation to increase their attractivity in a context of growing rates of higher education attainment. In this sense, this "modernization" may represent rather an identity crisis in TVET systems that creates space for the development of new conceptions and practices in vocational education.

Against this background, this paper presents the results of a critical discourse analysis of TVET modernization in the context of Brazil. By doing so, the paper seeks to discuss how the discourses on TVET modernization describe the multifaceted dynamics at play in the integration of TVET within the Brazilian systems of innovation. This includes an analysis of two main aspects: (1) the analysis of the representations on the roles of TVET organizations in the Brazilian system of innovation, and (2) the analysis of the representations of the roles of TVET graduates in innovation processes in Brazil. To do so, this paper departs from the assumption that when TVET policies delineate an envisioned future state of TVET systems (TVET modernization), they also reference the array of services that TVET systems must offer within innovation systems. In this paper, these services, as outlined in policy discourses, are construed as the roles of TVET systems within systems of innovation. Furthermore, policy discourses on TVET modernization underscore the significance of TVET graduates in labour markets and the specific tasks they are expected to undertake within diverse innovation processes.

This research identified that the discourses on TVET modernization among the SENAI and the Federal Network in Brazil reflect a radical approach that seeks to en-

hance the participation of TVET and TVET graduates in the linear model of innovation. On the other hand, SENAC – one of the major TVET providers in the country – reflect a conservative view that restrict the role of TVET institutions and TVET graduates in innovation processes.

In what follows, the paper is structured into different sections, starting with a brief review of contributions from previous literature, followed by a presentation of the theoretical and methodological framework, and an outline of the data collection procedures. The core of the paper presents a critical discourse analysis on Brazilian discourse emerging from recent innovation and TVET policies. The first level (Discursive Practices) focus on describing the Brazilian Hierarchical political economy, the innovation system and TVET landscape in Brazil. Following this, the second level of analysis (Text Analysis) is divided into three parts, examining challenges and goals in innovation discourses, TVET modernization, and TVET's roles in Brazil's innovation system. The last level of analysis (Discourses as Social Practices) discusses different perspectives on TVET modernization and its possible effects in terms of TVET and TVET graduates' participation in innovation processes.

## 2 Previous literature on the roles of TVET and TVET graduates in systems of innovation

The discussions on innovation processes within the academic world has evolved significantly over time, transitioning from a linear model approach to a more intricate and systemic approach (Godin 2006a). This transformation has been largely guided by the Systems of Innovation framework, which emerged at the close of the 20th century as a pivotal turning point in the field of innovation studies (Edquist 2010).

The initial paradigm, known as the Linear Model of innovation, delineated innovation as a sequential process encompassing five core stages: pure science, invention, innovation, finance, and acceptance (or diffusion) (Godin, 2008). This model emphasized the continuum between fundamental scientific research and engineering applications. It underscored the critical role of transitioning from fundamental research to applied research, mirroring the increased private sector investments in Research & Development (R&D) (Godin, 2006, 2008, 2012). This linear model primarily operated under the assumption that technical change flows from basic scientific research to applied research, eventually reaching production and diffusion stages (Godin, 2006b; Toner, 2010). This perspective advanced a staged progression, including knowledge generation, knowledge codification, and knowledge utilization (Kogut & Zander, 1992; Garud, Tuertscher, & Van de Ven AH 2013; Rupietta, Meuer, & Backes-Gellner 2021).

In contrast, the Systems of Innovation framework recognizes that innovation can manifest through different processes. Within this framework, at least two distinct modes of innovation can be delineated: the Science, Technology, and Innovation (STI) mode and the Doing, Using, Interacting (DUI) mode (Jensen, Johnson, Lorenz, & Lundvall, 2007). The STI mode focuses on formal processes of research and development, and it is characterized by a sequence of stages that reflect the linear model, encompassing knowledge generation, codification, and utilization. Conversely, the DUI mode thrives on in-

formal processes of learning and experiential knowledge. This mode often finds its locus at the company level, particularly among small and medium-sized enterprises (SMEs), operating within less R&D-focused knowledge environments (Thomä, 2017). It thrives on bottom-up learning and multi-directional knowledge flows, prioritizing practical know-how and adaptability over formal research.

However, while much scholarly attention has been directed towards the contributions of universities as knowledge institutions, the role of TVET has remained comparatively understudied. One of the few works available on this thematic (Toner, 2010) argues that TVET institutions are multifaceted entities within innovation processes, serving three distinct roles. First, these institutions are pivotal in disseminating practical skills and knowledge of production processes, thereby contributing to technology diffusion. Second, they function as intermediaries, facilitating the exchange of technology and information among producers, service providers, and organizations. Third, especially in regions lacking strong university or R&D presences, TVET colleges emerge as primary sources of technical expertise, offering crucial support for SMEs and industries seeking to adapt and incorporate existing technologies and innovations (Toner, 2010).

Moreover, the author argues that TVET graduates play an integral role in innovation processes through several avenues. Firstly, they contribute to innovation through experiential learning and hands-on experience, embodying the ethos of 'learning by doing' (Landes, 1972). Equipped with the skills necessary to design, install, adapt, operate, and maintain technology and equipment, TVET graduates are instrumental in practical problem-solving and innovation (Toner, 2010). Secondly, TVET graduates actively engage in public and private R&D activities, offering a valuable pool of skills and expertise tailored to problem-solving and the implementation of innovations (Toner, 2011). Their knowledge and aptitude for troubleshooting and optimization make them essential contributors to the innovation landscape. And thirdly, TVET graduates serve as adept users of capital, goods, and services, serving as valuable conduits for companies and public sectors to gather user feedback and insights. Their involvement in the user experience realm enables organizations to listen to users' needs and suggestions, facilitating continuous adaptation and innovation (Toner, 2010).

## 3 Theoretical and Methodological Framework: Cultural Political Economy (CPE) and Critical Discourse Analysis (CDA)

This paper seeks to answer the following questions:

1. How do discourses on innovation and TVET represent the roles of modern TVET systems in systems of innovation in Brazil?
2. How do discourses on innovation and TVET represent the roles of TVET graduates in different innovation process in Brazil?

To answer to these questions, the research adopted a comprehensive theoretical and methodological framework rooted in Cultural Political Economy (CPE) and Critical Discourse Analysis (CDA). CPE serves as our overarching theoretical lens, offering a

macro-level perspective. It investigates the intricate relationships between policy discourses, economic and political ideologies, and their translation into concrete strategies, projects, and institutional structures (Jessop, 2008, 2010). This framework emphasizes the pivotal role of semiosis and discourses in shaping economic and political realities (Jessop, 2010).

At its core, CPE contends that socio-political transformations are the outcome of a nuanced interplay between material and semiotic elements, orchestrated through mechanisms known as variation, selection, and retention (Sum & Jessop, 2013). Variation encompasses the emergence of new or different policy discourses and practices in response to a myriad of factors. Selection involves the identification of the most suitable interpretations of existing problems and the corresponding policy solutions. These selections vary across different contexts due to distinctive political economy structures and ideological coalitions. Lastly, retention refers to the institutionalization of newly adopted discourses and policies.

As a methodological approach, we employ Critical Discourse Analysis (CDA), as developed by Norman and Isabela Fairclough, to investigate the role of language within social and cultural processes (Fairclough, 2003). The term language here is used to refer to discourses. CDA views discourses as both a reflection of social reality and a powerful instrument that actively shapes and influences it. CDA operates across three analytical layers:

- Discursive Practices: It investigates the contextual factors that shape discursive practices, including institutional and organizational dynamics. This analysis aims to map the key actors involved in producing and disseminating discourses and to understand the conditions that facilitate discourse production through a discussion concerning the Brazilian hierarchical political economy (Schneider, 2008a).
- Discourses as Texts: This layer involves a detailed language analysis of texts using an argumentative text analysis. This approach involves analysing premises related to circumstances, goals, values, actions, and means (Fairclough & Fairclough, 2011, 2012).
- Discourse as Social Practices: This final layer interprets discourses within the broader social context, assessing their impact on society and their role in driving social transformation. (Fairclough, 2003).

## 3.1 Data Collection Procedures

The data collection procedures for this research were conducted to ensure a comprehensive exploration of the TVET landscape in Brazil and its integration into the country's innovation system. Data was gathered through two primary methods: document analysis and semi-structured interviews, involving key stakeholders at various levels. Data collection procedures encompassed two distinct geographic levels:

- National Levels: Data collection at the national level centred on examining national policies and institutional frameworks related to innovation and TVET in Brazil. It provided insights into the overarching strategies and initiatives at the country level.
- Local Levels: The local level data collection involved observing the perceptions and interactions of different actors within a specific local system of innovation. Emphasis was placed on the Energy sector, with a focus on the 'APL Oil and Gas Macaé' in Brazil. In this research, the use of the local level has been important to identify variations in the discourses on innovation and TVET in Brazil, however, the main focus of the analysis remains in the national level.

## Local Productive Arrangement – APL Oil and Gas Macaé

The 'APL Oil and Gas Macaé' was a significant focal point of the research. This arrangement refers to a local innovative cluster, as described by Cassiolato and Lastres (2003). It represents territorial agglomerations of economic, political, and social agents focused on specific economic activities. In the Campos basin of Rio de Janeiro, Petrobras established one of the world's largest marine oil complexes. The governance of 'APL Oil and Gas Macaé' is managed through the 'Petro Network,' a non-profit organization dedicated to promoting, articulating, and fostering business generation within the oil, gas, and energy production chain of the Campos Basin. Notably, the Petro Network includes over 70 private companies, 24 public or non-profit institutions, and major TVET networks in Brazil, such as SENAI, SENAC, and the Federal Network.

## Documents analysed

A wide array of documents, encompassing both national and local perspectives, was collected. These documents covered the period from 2011 to 2019 and provided insights into various facets of innovation and TVET policies in Brazil. The selection of the documents, considering time and labour constrains, was not designed in a way to cover a large number of publications produced by each of the stakeholders. For this reason, only one annual report has been selected within the covered period from 2011 and 2019.

The significance of the analysed documents lies in their ability to offer a multifaceted view of the integration of TVET into Brazil's innovation system. These documents represent a diverse array of perspectives, ranging from governmental strategies to industry-specific challenges, providing a comprehensive spectrum for critical discourse analysis. More importantly, the documents present the circumstances, goals, values, actions, and means (Fairclough & Fairclough, 2011, 2012) highlighted by the discourses on innovation and TVET policies. The list of documents include:

- Business Mobilization for Innovation (MEI) New Agenda to Expand Business Innovation (CNI, 2014a): This publication detailed the updated work agenda of MEI, reflecting the collective input of prominent business leaders and government officials involved in the initiative.
- National Science, Technology and Innovation Strategy 2016 (MCTIC, 2016): This strategic document outlined the medium-term Science, Technology, and Innovation (ST&I) strategy during President Michel Temer's tenure (2016–2018).

- Challenges for Industry 4.0 in Brazil (CNI, 2016): Organized by the Permanent Thematic Council for Industrial Policy and Technological Development within the National Industry Confederation (CNI), this publication delved into the concepts of 'digitalization' and 'Industry 4.0.'
- Industry 4.0 (ABDI, n.d.): This online portal (no longer available) presented the MCTIC's comprehensive strategy for Industry 4.0 in Brazil, crafted by the Working Group for Industry 4.0 (GTI 4.0) in 2017.
- The Pernambuco Declaration (SBPC, 2018): This concise publication produce by Brazilian Society for the Progress of Science (SBPC) summarized twelve key points regarding Brazilian science, technology, and innovation policy.
- Technology Roadmaps Planning 2015–2020 (FIRJAN, 2015): The document produced by the Federation of Industries of the State of Rio de Janeiro (FIRJAN) was developed collaboratively with around 120 specialists in 2014, focusing on research and development collaboration, identifying strategic areas, and addressing industrial demands in the state of Rio de Janeiro.
- Annual Report on the Analysis of the Management Indicators of the Federal Institutions of Professional, Scientific and Technological Education. Year 2018 (MEC 2019): This report, organized by the Secretariat of Professional and Technological Education (Setec) of the Ministry of Education (MEC), presented an overview of the management indicators of the TVET Federal Network in 2018.
- Portraits of the Brazilian Society: Professional Education (CNI, 2014b): This publication presents the results of a national research initiative conducted by the National Confederation of Industry (CNI) regarding the perception of TVET in Brazilian society.
- Management Report NEPI (MEC, 2018): This report summarized the activities of the 'Structuring Center of Innovation Policy' (NEPI/SETEC) within the federal Ministry of Education for the year 2016. Focusing on the 'Innovation Policy in the Federal Institutes,' the publication outlined 22 activities undertaken by NEPI.
- Annual Report of Activities SESI-SENAI-IEL 2018 (CNI, 2019): This report provided a national summary of the activities carried out by the entire 'Industry System,' including SESI, SENAI, and IEL, in the year 2018.
- SENAC General Report 2018 (SENAC, 2019): This publication presented a national summary of the activities conducted by SENAC in the year 2018.
- SENAC Pedagogical Model Guidelines (SENAC, 2018): This document provided an overview of the principles governing SENAC's new national pedagogical model, which had been developed through ongoing dialogue with SENAC Regional Departments since 2013.
- 2018 Management Report SENAC-RJ (SENAC RJ, 2019): This report summarized the activities of SENAC's Regional Department in Rio de Janeiro during the year 2018.
- 2019 Management Report SENAI-RJ (SENAI RJ, 2019): This report presented an overview of SENAI-RJ's institutional objectives, organizational planning, and activities in 2019.

### Semi-structured expert interviews

Moreover, semi-structured interviews were conducted with key stakeholders to gain a deeper understanding of TVET policies and innovation strategies. The selection of the interviewees was defined by a multilevel strategy that include national and local stakeholders from innovation and TVET landscapes. The interviews were held at various geographic levels, including both national and local perspectives:

- Ministry of Science, Technology, and Innovation (MCTIC): An interview was conducted with a representative from the Department of Technological Development and Innovation. Duration: 46 minutes. Code: MCTIC.
- Ministry of Education I (Brasilia, 19.10.2017): Interview with the former secretary of TVET. Duration: 90 minutes. Code: FormerMEC.national.
- Ministry of Education II (Brasilia, 17.10.2017): Interview with two representatives of the 'Structuring Center of Innovation Policy' (NEPI). Duration: 90 minutes. Code: MEC.national.
- National Service of Commercial Apprenticeship (Rio de Janeiro, 24.10.2017): Interview with the representative of the TVET section at the SENAC national department. Duration: 80 minutes. Code: SENAC.National.
- National Service of Industrial Apprenticeship (Rio de Janeiro, 06.11.2017): Interview with two representatives of SENAI's innovation department in the state of Rio de Janeiro. Duration: 75 minutes. Code: SENAI.RJ
- Federal Institute for Vocational Education Fluminense (Campos dos Goytacazes, 02.11.2017): Interview with the representative of the IFF Innovation department. Duration: 80 minutes. Code: IFF.local.
- Petro-BC Network: Interview with the representative of the network management. Duration: 99 minutes. Code: RedePetro

## 4 Discursive practices: Brazil's Hierarchical Political Economy as a Landscape of Challenges in Innovation, Education, and Skills

The Global Competitiveness Index of 2018 positioned Brazil as the 72nd most competitive economy globally, yet it stood out as the most innovative nation in South America, ranking 40th overall. However, the nation's performance in innovation is constrained by institutional factors, particularly the poor integration of policies and the lack of coordination between the public and private sectors (World Economic Forum, 2019).

This paper argues that the integration of TVET within systems of innovation at both the national and local levels in Brazil is embedded within a hierarchical political economy (Murillo, 2001). This framework is characterized by distinctive traits, including a strong sense of hierarchy, fragmented collective agents, and inefficient regulation and collective bargaining (Murillo, 2001). Additionally, Bresser-Pereira (2012) characterizes this context as a liberal-dependent model, highlighting the dependency of its elites to varying degrees and the absence of a cohesive national development strategy.

Integral to Brazil's hierarchical market economy is a concentrated ownership structure, with a significant portion of companies, including multinational corporations (MNCs), controlled by a handful of powerful families, forming large economic groups (Schneider, 2008a). This concentration extends to business associations, which often lack the capacity for self-governance at the industry level due to their limited influence over decisions made by economic groups or MNCs within their sectors (Schneider, 2004). This reality is exacerbated by the weakness of unions within companies and industries, further diminishing the bargaining power of associational intermediaries.

Furthermore, Brazil's competitive landscape is shaped by the absence of robust competition policies and effective legislation concerning public contracts. Economic groups and MNCs enjoy privileged access to information and capital, fostering a symbiotic relationship with the political system (Schneider, 2008b).

Within this hierarchical market economy, Brazil's educational system exhibits a strong social disparities. The elite classes access superior human capital resources, while the working classes are relegated to a second-tier education (Frangi, 2012). A substantial portion of the workforce in Brazil possesses limited educational attainment, primarily engaging in the informal sector, characterized by low wages, job insecurity, and a dearth of training opportunities. In contrast, a select few enjoy stable careers in the public sector, MNCs, or large domestic enterprises, contingent upon higher education qualifications (Schneider & Soskice, 2009). Employees at large firms typically experience long tenures, union representation, and significant legal protection. Although some prominent companies, particularly MNCs in sectors such as automobile manufacturing, invest in specific in-company training for a core workforce, this training is not widespread due, in part, to the preference of large firms for poaching skilled workers by offering higher wages.

Significant economic groups and MNCs in Brazil have shown limited inclination to invest in innovation or research and development activities. Technology imports from advanced economies remain the norm, and there is minimal focus on innovation-driven export markets, as success within oligopolistic markets often relies more on market power than product development (Schneider & Soskice, 2009). MNCs tend to conduct research outside Latin America, primarily in their research structures in developed countries.

Recent studies (Cassiolato, Szapiro, & Lastres, 2015) underscore the concentration of R&D expenditures in Brazil within a few sectors, with substantial emphasis on the automobile industry. Large locally owned firms also exhibit a high level of concentration, notably in oil refining and the 'other transport equipment' sector, as exemplified by Embraer, the renowned Brazilian aircraft manufacturer (Cassiolato, Lastres & Maciel, 2003).

In Brazil, while the majority of the economic sectors present lower levels of innovation and R&D, innovation assumes paramount importance in the competitiveness strategies of sectors linked to the export of primary goods. Despite a reliance on imported technologies, these sectors often engage in local technology development, often in collaboration with institutions like the Brazilian Agricultural Research Company (Embrapa) and the National Institute for Space Research (INPE) (Cassiolato et al., 2015).

## 4.1 Brazilian Innovation System and Its Main Actors

The Brazilian innovation landscape is complex and dynamic, involving a multitude of actors from various sectors. These actors play pivotal roles in shaping the country's innovation policies and practices. Below is a detailed description of the key actors within the Brazilian Innovation System (MCTIC, 2016):

- Ministry of Science, Technology, and Innovation (MCTIC): While it was extinguished in 2019 (recreated later on), the MCTIC held a critical role in formulating and executing national policies for scientific and technological research and innovation. It coordinated, supervised, and controlled activities in these domains, including serving as the coordinator of the Brazilian Innovation System.
- Ministry of Education (MEC): The MEC is a crucial federal ministry responsible for providing guidelines and funding for various educational policies, spanning primary, secondary, tertiary, adult education, technical and vocational education and training (TVET), special education, and distance education. It also evaluates research programs in the field of innovation.
- National Council of Science and Technology: Established in 1996, this advisory body reports to the President of the Republic. Its primary role is to formulate and implement national policies for science, technology, and innovation. The Council proposes science and technology policies, formulates plans, establishes national priorities, and evaluates policy execution, offering guidance for innovation programs and regulatory acts.
- Regulatory Agencies: These relatively recent entrants into the Brazilian Innovation System are legally obligated to invest in science, technology, and innovation activities within their regulated sectors. Agencies like the National Agency of Petroleum, Natural Gas, and Biofuels (ANP) and the National Electric Energy Agency (Aneel) manage sectoral funds with Research and Development (R&D) clauses to promote private investment in innovation.
- State Secretariats: Each of Brazil's federal states has its innovation secretariat, serving as coordinators and financiers of regional innovation systems. These secretariats, alongside governance of 'Research Support Foundations,' form part of the articulation efforts at both the state and national levels. Two key representative bodies include the 'National Council of State Secretaries for Science, Technology, and Innovation Affairs' (Consecti) and the 'National Council of State Research Support Foundations' (Confap).
- Employers Confederations: National Confederation of Commerce (CNC): CNC, along with other national confederations like the National Confederation of Agriculture (CAN) and the National Confederation of Industry (CNI), represents various organized private sectors in Brazil. CNI, in particular, promotes public policies supporting innovation in industrial production.
    - Business Mobilization for Innovation (MEI): MEI, coordinated by CNI, is an initiative of more than 200 business leaders, government authorities, and institutional representatives. It seeks to enhance collaboration between the public and

private sectors in Brazil's innovation system to boost the effectiveness of public innovation policies.

- Trade Unions: Trade unions in Brazil are organized around central bodies that coordinate workers' representation and engage in high-level negotiations. For instance, the Unified Workers' Central (CUT), founded in 1983, is the largest union center in Brazil and Latin America, representing millions of workers. The Sindical Force, founded in 1991, also has a significant presence.
- Science Associations: It includes for example the Brazilian Academy of Sciences (ABC), the Brazilian Society for the Advancement of Science (SBPC).
- Funding Agencies: Includes the National Council for Scientific and Technological Development (CNPq), who promotes scientific and technological research and supports the training of Brazilian researchers, and the Coordination for the Improvement of Higher Education Personnel (CAPES). More recently, the creation of the Brazilian Association for Industrial Research and Innovation (EMBRAPII) in 2013 seeks to foster innovation in Brazilian industry by promoting synergies between research institutions and industrial companies. Finally, the Research Support Foundations (FAPs) are state-level agencies, including the Foundation Carlos Chagas Filho Research (FAPERJ), that offer funding for research projects, scholarships, scientific infrastructure, and educational curriculum updates.
- Science, Technology, and Innovation Operators: These entities are responsible for developing and implementing science, technology, and innovation activities. It includes the Federal Higher Education Network and State Universities; The National Institutes of Science and Technology (INCT) established in 2008; The Federal Institutes of Education, Science, and Technology (Federal Institutes), as well as the SENAI Innovation Institutes

## 4.2 The Brazilian TVET Landscape

In the area of Technical and Vocational Education and Training , Brazil showcases a landscape marked by diverse actors operating with limited interinstitutional coordination and complementarity. This section delineates the key TVET actors (Souza et al. 2015) within Brazil's multifaceted TVET systems, primarily comprising the TVET National Federal Network (public), state funded TVET schools, and the 'S system,' featuring institutions like SENAI and SENAC, which TVET providers under the organization of the Chambers of Commerce.

The organization of TVET in Brazil is characterized by historical dualities and distinct perspectives on the objectives and structure of TVET systems. These dualities encompass divisions between public and private TVET systems, as well as the fundamental duality within the education system itself, where TVET is juxtaposed with higher education.

Brazilian TVET legislation provides substantial autonomy to TVET institutions to define the scope of their activities and the development and approval of TVET programs. This autonomy, however, comes with limited guidance on structuring TVET provision. Public and private TVET institutions in Brazil tend to develop their own concepts and frameworks, enjoying a high degree of institutional autonomy.

Notably, private TVET institutions like SENAI and SENAC employ competency-based curricula, which organize TVET programs around the development of professional competencies. These institutions implement national pedagogical models that emphasize learning through practical experience and active student participation. Competence is defined as observable professional action (SENAC, 2018) in these models, emphasizing its articulation with knowledge, skills, attitudes, and values. TVET curricula are modular, with each curricular unit corresponding to a specific competency.

In contrast, institutions within the Federal Network have historically resisted the use of competency-based curricula in TVET. The Federal Network operates with a high degree of autonomy across administrative, patrimonial, financial, didactic-pedagogical, and disciplinary dimensions, as stipulated by Federal Law number 12.677 of 2012. the Federal Network places a strong emphasis on the inseparability between teaching, research, and extension, reflecting its commitment to integrating these components.

The Brazilian public TVET landscape encompasses various public actors at both national and local levels. These entities play pivotal roles in shaping the country's TVET policies and systems (Souza et al. 2015):

- Ministry of Education (MEC): At the apex of Brazil's educational policy coordination, the MEC is responsible for formulating the nation's educational policy and implementing the 'National Education Plan (NPE) 2014–2024.' The Secretariat of Professional and Technological Education of the Ministry of Education (SETEC/MEC) operates under the MEC's umbrella, steering TVET policies, programs, and actions. SETEC is also entrusted with developing and updating national guidelines for TVET courses, certifications, and recognition of professional competences. It plays a crucial role in devising teaching methodologies, evaluation frameworks, and management models for public TVET institutions. Additionally, within MEC's purview, the National Institute of Educational Studies and Research (INEP) conducts vital assessments and supports policy development, while the Coordination for Improvement of Higher Education Personnel (CAPES) evaluates graduate programs offered by TVET schools.
- The Federal Network of TVET Institutes: Established in 2008, the Federal Network constitutes a significant milestone in Brazil's TVET expansion. Comprising three main types of TVET institutions—Federal Institutes, Technical Schools affiliated with Federal Universities, and Technological Centers (along with a few universities)—this network boasts over 40 TVET institutions and over 600 TVET centres scattered across the country. These institutions wield autonomy in course creation and diploma registration within their territorial domains. The National Council of Institutions of the Federal Network of Professional, Scientific and Technological Education (Conif) serves as the principal platform for policy discussions, propositions, and the promotion of training, research, and innovation. Conif also spearheads various initiatives, including research projects and knowledge exchange forums.
- State Secretariats and TVET Schools: Brazil's State Education Secretariats hold the authority to authorize, certify, monitor, and evaluate local educational institutions. Notably, in Rio de Janeiro, the State Education Secretariat (SEEDUC) operates a network of local TVET schools and offers TVET courses, often integrated with secondary

education. The National Council of Education Secretaries (CONSED) plays a pivotal role, uniting state representatives to foster the integration of state education networks and amplify state participation in national policy decision-making. Another significant contributor to the state TVET network is the Foundation for the Support of Technical Schools (FAETEC), an entity linked to the State Secretariat for Science and Technology.

Brazil's private TVET systems encompass a range of public and private actors at national and local levels. These actors include the Ministry of Labour and Employment (now the Ministry of Economy), various institutions within the 'S system,' and other private TVET schools:

- Ministry of Labour and Employment: Responsible for enforcing apprenticeship legislation and overseeing the apprenticeship system, the Ministry of Labour and Employment ensures that companies maintain a mandatory quota of 5 % of young employees through specialized work contracts. The ministry's functions include organizing the Brazilian Classification of Occupations (CBO) and maintaining the national registration of qualified apprenticeship institutions. It establishes rules for assessing the competence of entities, validates apprenticeship programs and courses, and compiles data on new apprenticeship contracts.
- National Apprenticeship Services (S System): The S System, comprised of nonprofit private entities functioning as autonomous social services, is a crucial player in Brazil's TVET policy landscape. These entities provide over 40 % of the country's TVET offerings. Prominent members of the S System include SENAI (focused on the industrial sector), SENAC (concentrating on Commerce and Tourism sectors), SENAR (operating in rural areas), and SENAT (providing safety programs and vocational training in the transportation sector). A substantial portion of their revenue stems from mandatory taxes levied on firms in different sectors, with a portion earmarked for the provision of free professional and technical education programs. These institutions adhere to a corporate governance model characterized by a confederation structure, featuring national and regional departments, councils, and fiscal councils. Notably, a tripartite composition—Government, Workers, and Entrepreneurs—comprises the National Councils of these entities, as agreed upon with the Ministry of Education in 2009.
- Other Private TVET Institutions: Beyond the National Apprenticeship Services, private TVET institutions, including private higher education institutions offering high school technical courses and private secondary schools, are emerging as potential TVET providers, contributing to the diversification of Brazil's TVET landscape. The presence of other private TVET institutions in the country is limited and, for that reason, this category of stakeholders has not been included in the data collection procedures.

## 5 Text Analysis

This section aims to present the results of the text analysis of the documents and interviews concerning TVET policies at national and local level in Brazil. The texts from interviews and documents are analysed to identify (1) current challenges and goals of innovation discourses in Brazil; (2) the challenges and goals of TVET discourses in Brazil; and (3) the role of modern TVET systems in innovation systems and the role of TVET graduates in innovation processes.

### 5.1 Challenges and goals of Innovation Discourses in Brazil

The analysis of the texts from documents and interviews spanning from 2011 to 2019 unveils significant findings and key challenges within Brazil's innovation policy landscape. In general, the documents and interviews concerning innovation policies at national and local level in Brazil present an idea of innovation focused on activities of applied research as the source of innovation, in contrast to basic research. This approach has been reinforced with the establishment of Embrappi in 2013, a model inspired by the German Fraunhofer Institute model. However, they also recognize that, historically, innovation policies in Brazil have faced a persistent challenge – the lack of prioritization of science and research within the country's social and economic development agenda. This is a recurring theme emphasized across various documents and interviews. The document "MEI's New Agenda to Expand Business Innovation: The State of Innovation in Brazil," published by the MEI in 2014, underscored this issue, for example, by asserting that "low levels of public and private investments in research and development are one of the main barriers in the development of innovation in Brazil" (CNI, 2014a, p. 4).

The documents and interviews highlight challenges concerning substantial reduction in public investments in innovation policies from the second half of 2010's in Brazil. The representative of SENAI at the national level highlighted that during the government of former Vice President Michel Temer (2016–2018), there was "a lack of political influence from the MEI and the CNI in promoting the participation of the federal government in innovation policies" (SENAI.National).

An issue that the interviews bring to the forefront is the limited interaction between Brazil's higher education system and the business sector. A representative of SENAI in Rio de Janeiro pointed out, "There are islands of excellence here that we find throughout the country […] these are universities that have a research history that is relevant […] but that for some reasons, they are a little distant from companies, from industries" (SENAI.RJ).

Another pressing concern demonstrated in the interviews and documents is the process of deindustrialization witnessed in Brazil's national economy in the last decades. The industrial sector, which once contributed over 20 % to the national GDP in the early 1980s, saw its share decline to a mere 11 % by 2016 (ABDI and MICS, n.d). Innovation discourses highlight that this industrial decline poses a considerable challenge to innovation policies aiming to bolster the international competitiveness of Brazil's industries, as competitiveness is seen as direct consequence of the level of innovation in this economic sector. Brazil's industrial sector has experienced a diminishing role in the national econ-

omy, characterized as an early deindustrialization phenomenon (Cassiolato & Lastres, 2017).

The interview with the representative of the Petro-BC Network (Rede Petro) depicted a scenario where sectors like Oil and Gas and "the area of production (Campos basin) is almost completely disconnected with the processes of innovation development in the sector of Oil and Gas." In the view of the representative, institutional challenges also hinder progress, particularly in the case of the Rede Petro, which lacks proper legal recognition. The representative explained, "the lack of a proper legal structure creates a scenario where the Rede Petro has low access to financing and must work on an extremely small budget of approximately 6,000 reais per month (less than 1,000 dollars) financed by its members" (Rede Petro).

Against this background, the analysis unveiled two main policy goals in innovation discourses in Brazil: first, the objective of reducing the technological gap between the country and developed nations, and second, the objective of leveraging innovations and technologies to bolster economic competitiveness. The interviewee from SENAI at the national level stressed the importance of closing the technological gap, noting, "National companies, as a rule, are technologically dependent [...] it brings this agenda into the institution, to try to close these technological gaps."

## 5.2 Challenges and Goals of discourses on TVET modernization in Brazil

The discourses that emerge from the interviews and document surrounding TVET modernization in Brazil reflects different challenges and objectives, including issues of social inequality, constraints on public investments, and the need to adapt to global discourses on innovation.

The documents and interviews underscore a stark scenario of social inequality related to access to education, TVET, and employment within Brazil. According to the SENAC 2018 National Report, data from the 2017 IBGE's National Continuous Household Survey (Pnad) revealed that two out of every ten young Brazilians neither study nor work, indicating a concerning trend (SENAC, 2019). Furthermore, a study by CNI (2014b) highlighted a significant disparity: 42 % of respondents with higher degrees had taken or were taking professional education courses, whereas this percentage plummeted to a mere 5 % for those with up to a 4th-grade elementary school education.

Moreover, since the onset of Michel Temer's presidency in 2016, Brazil's TVET policies have encountered significant budget cuts, mirroring the challenges faced by innovation policies during the same period. This period witnessed a competitive scramble for public investments in TVET. During an interview in late 2017, a representative of SENAC at the national level described Brazil as a country engulfed in political and social turmoil, with a critical search for resources (SENAC.National). At the local level, within the state of Rio de Janeiro, documents and interviews related to TVET policy painted a similar picture. For example, the 2018 SENAC-RJ Management Report depicted an economic crisis in the state, compelling the institution to take significant cost-cutting measures (SENAC RJ, 2019).

The challenges of social inequality related to access to education, as well as the significant budget cuts in the field of education and TVET convergence towards a general

concern with the need to increase labour productivity and social inclusion. Against this background of main challenges described by the documents and interviews, TVET policies in Brazil revolve around key objectives, with a shared focus on enhancing labour productivity, bolstering economic competitiveness, and promoting social inclusion. These goals are echoed at both national and local levels, as showed by interviews and document at local level. However, a distinctive objective emerged in the discourses from TVET policies of the Federal Network of TVET Institutes and SENAI, which was not as pronounced in the case of SENAC: obtaining additional funding by providing services related to innovation development, such as applied research and consultancy services.

Institutions such as those within the Federal Network and SENAI have a vested interest in promoting the vision of modernity to secure additional funding, particularly in an environment characterized by reduced public investments. A representative from the former SETEC/MEC administration emphasized the need for institutions in the Federal Network to explore alternatives to sustain their model of excellence. This includes establishing specialized units for innovation with the aim of raising funds from the private sector (FormerMEC.National).

## 5.3 The Different Roles of TVET in Brazil's System of Innovation

In Brazil, TVET organizations are emerging as critical actors in innovation policies, particularly those within the Federal TVET network and the SENAI network (CNI, 2014a; MCTIC 2016). These organisations are now recognized as science and technology institutions with a mission encompassing technological research and development (MCTIC 2016). The representative of the MCTIC accentuated their role, asserting that, "today, the Federal TVET Institutes and the SENAI innovation institutes have higher education courses. We have master's and we have doctorates […] partnership with EMBRAPII with MCTIC, with MEC, can really create this different culture" (MCTIC).

The role of TVET in the systems of innovation in the case of SENAI and the Federal Network in Brazil is presented by the documents and interviews as the result of a broad process of TVET transformation that seeks to combine the provision of skilled workers and activities related to technology transfer. In both cases, the representation of TVET modernity is based on an attempt to enhance the participation of TVET institutions in systems of innovation and TVET graduates in processes of innovation development highly centred on the activities of research and development, with a focus on applied research projects and public partnerships.

Within the Federal Network, the role of TVET in innovation is intertwined with the fundamental concept of 'inseparability between teaching, research, and extension', a paradigm described by the Brazilian Federal Constitution of 1988 as the main principle that should guide the work of universities. The federal law number 9.394 of 1996 (Brasil, 1996, own translation, art. 43) establishes the guidelines and bases of national education and describes the work of teaching as training "graduates in different areas of knowledge, suitable for insertion in professional sectors and for participation in the development of Brazilian society, and to collaborate in their continuous training". Research is defined by the law as "scientific research and investigation, aiming at the development of science and technology and the creation and diffusion of culture. Lastly,

the term "extension" is described as "the dissemination of the achievements and benefits resulting from cultural creation and scientific and technological research generated at the institution" (Brazil, 1996, own translation, art. 43).

The decision of using this concept to orient the organization of the Federal TVET Institutes, reinforces the need for educational institutions to consider an institutional strategy on the relationship with external partners and society. By doing so, it also opened an opportunity for this TVET providers to deliver not only training programmes and activities but also scientific research and investigation with the objective of promoting impact on the communities and environment (extension).

Interviews with representatives of this network underscore the paramount importance of applied research as a means of addressing tangible problems. A senior official from the SETEC/MEC administration emphasized the distinctive mandate of TVET institutions within the Federal Network to actively engage in solving real-world issues through applied research. According to this representative, this commitment is rooted in a long-standing TVET tradition that emphasizes practical solutions and the transformation of academic knowledge into tangible products that resonate with the productive sector. Moreover, the verticalization of TVET supply within the Federal Network is a prominent feature. The introduction of professional master's and doctoral programs within the TVET system (different than traditional masters and doctoral programs provided by Universities)signifies a pivotal shift toward fostering applied research at the graduate level. According to this representative, these programs are designed around real-world projects aimed at finding solutions to critical sector-specific problems, positioning TVET graduates as catalysts for innovation development.

Furthermore, SENAI places an equally strong emphasis on research-oriented activities seeking a symbiotic relationship between these activities and the provision of a skilled workforce. SENAI representatives have articulated a vision that aligns the training of skilled workers with technology transfer and innovation development in the Brazilian industrial sector. This discourse on TVET modernization suggests that the provision of research and technology transfer services can help TVET providers to stay updated on the needs and modern requirements in terms of technology, , equipment, machinery and the new skills in TVET curricula, therefore, facilitating the provision of skilled workers. . This approach is also substantiated by a commitment to the verticalization of TVET supply, mirrored by the establishment of professional master's and doctoral programs. These programs, characterized by project-based learning, are attuned to the resolution of practical problems in various sectors and play a pivotal role in positioning TVET graduates as active contributors to the innovation landscape.

Along with this line, the discourses from Federal Network and SENAI highlight the central role of TVET graduates as innovation developers – and not only implementers (or 'competent users' as described by Toner 2010). For example, as suggested by the representative of the SENAI at local level:

> "The company brings a demand. And this problem is taken to vocational education students, and they seek that solution, that innovation. So, it is a way for us to stimulate in this moment of formation the look for innovation, looking for a solution. I mean, this professional who will leave here trained, he will be a professional within a

> company. He will leave here with that concept that if he is within the company, he will always have to be looking for solutions and innovations for that activity" (SENAI.Local, own translation).

On the other hand, the case of SENAC emerges as a variation in the national discourses with a strict focus on the provision of skilled workers. The institution's primary role within Brazil's system of innovation predominantly centres on supplying a highly skilled workforce in commerce and tourism sectors. At SENAC, the innovation agenda is focused into the discussions of the changes in future skills demands caused by the introduction of disruptive technologies in these sectors.

The focus on the provision of skilled workers is also reflected in the representation of the services offered by SENAC-RJ. According to SENAC-RJ (2019, own translation, p. 25), the services focus on transforming the demands from "governments, companies, unions, employers' associations and civil entities" into several types of TVET courses, courses' content and learning activities including secondary- and tertiary-level TVET, as well as short-term courses, specializations, distance learning programs, book publications, and customized projects for companies, public agencies and social entities.

In the last years, the cornerstone of its modernization efforts revolves around the development and implementation of the SENAC National Pedagogical Model. For SENAC, it entails aligning TVET courses closely with employers' needs, ensuring that the skills and competencies imparted to students are in high demand within the job market. By doing so, SENAC seeks to foster the employability and "productive inclusion" of young and adult individuals, effectively integrating them into the workforce (SENAC.National).

The framework of the SENAC National Pedagogical 230 Model describes the special curricular unit of 'integrating project' as a practical proposal of effect. In the development of 'integrating project' and innovative solutions, TVET graduates are expected to present the SENAC's formative marks, namely the entrepreneurial, sustainable and collaborative attitudes, technical-scientific expertise, and critical view. In SENAC's discourse on the development of 'integrating project' and innovative solutions, TVET graduates can be represented both as innovation 'developers' and 'implementers'. As implementers, TVET graduates must shows the skills required by new technologies in commerce and tourism. However, while acting as developers of innovation through 'integrating projects', TVET students are not provided the opportunity to be inserted in scientific activities as it is in the case of SENAI and the Federal Network. The kind of innovation developed by TVET students is rather the result of project-based learning detached from the activities of research and development in cooperation with private companies and universities.

Against this background, this research identified that the discourses on TVET modernization among the SENAI and the Federal Network reflect a radical approach that seeks to enhance the participation of TVET and TVET graduates in the linear model of innovation in Brazil. In this way, TVET and TVET graduates are presented as main actors also in the processes of technology and innovation development. On the other hand, SENAC – one of the major TVET providers in the country – reflect a conservative view that restrict the role of TVET institutions and TVET graduates in processes of installing, adapting, operating, and maintaining technology and equipment.

## 6 Discourse as social practice: different possibilities of TVET modernization in Brazil

This last analytical section briefly compare the different perspectives on TVET modernization in Brazil and its possible effects in terms of TVET and TVET graduates' participation in innovation processes.

National and local discourses on TVET in Brazil frequently make use of the expression 'TVET modernization' to describe the process of adapting, changing or reforming current TVET systems to achieve a desirable future state (MEC, 2018; CNI 2019; SENAC, 2019).

However, as showed in the last section, the effects of the different discourses on TVET modernization in terms of participation of TVET and TVET graduates in systems of innovation can be quite different.

The analysis of the discourses in Brazil showed two different perspectives of TVET integration in systems of innovation, that will be here described as 'conservative TVET modernization' and 'radical TVET modernization'[1]. These two categories are based on an interpretative exercise: discourses based on the conservative TVET modernization approach, as seen in the case of SENAC, suggests that modern TVET systems must focus on traditionally established TVET services – mainly skills development through training. Within this specific discourse, TVET modernization is characterized rather as a process of adjustments or improvements in traditionally established TVET services. On the other hand, the discourses based on a radical TVET modernization seek to incorporate new types of TVET services, which redefines the nature of TVET systems and by doing so, suggests different roles of TVET in systems of innovation. The radical TVET modernization approach was identified in the case of SENAI and the Federal Network in Brazil.

In this context, the conservative discourse seems to reinforce a representation of TVET as an important mechanism of skills formation, while other educational institutions, such as universities and research institutes are perceived as producers of knowledge through basic and applied research. Within this discourse on TVET modernization, the main role of TVET is to provide skilled individuals to act as workers and competent users of technology in contexts of substantial shifts in labour demands and the use of technology in labour markets. By doing so, this conservative approach departs from a scenario where TVET is located in the end of a linear model of innovation. This suggests that SENAC selectively excludes TVET schools from adopting different roles in the Brazilian innovation system, as it remains seen as a type of institution that does not generate or codify knowledge.

On the other hand, the radical discourse on TVET modernization presents a broad process of TVET transformation, in which TVET institutions compete and collaborate with universities in innovation processes highly centred on the activities of research and development, with a focus on applied research projects, while the provision of TVET skilled workers remains at the core of the services provided by TVET. Against this background, the TVET policies in the Federal Network and SENAI also present the objective

1 The use of the terms radical and conservative modernization here refers exclusively to the degree of change that is reflected in the discourses.

to obtain extra funding through the provision of services related to the development of innovation. In both cases, the integration of technology transfer, applied research, and the provision of a skilled workforce is central to the modernization efforts. This vision of TVET institutions as innovation hubs does not excludes the most traditional focus on skills formation, as it remains an important contribution of TVET to innovation policies. It rather seeks to create a symbiosis between training programmes and research-oriented activities.

Lastly, this paper argues that both radical and conservative discourses seem to corroborate Toner's representation on the roles of TVET graduates in the DUI mode (learning by doing), which include "design, install, adapt, operate and maintain equipment, software and other technologies" (Toner, 2010, p. 80). However, the different perspectives (conservative and radical modernization) seem to highlight different roles of TVET graduates within the linear model (STI mode). SENAI and the Federal Network highlight the participation of TVET graduates during the whole STI mode, which includes not only the utilisation of knowledge and technologies but also a crucial participation on the generation and codification of knowledge in the STI mode. In the case of SENAC, the participation of TVET graduates in the linear model is often presented within the world of 'praxis'. This suggests a view of TVET graduates as 'competent users' of the knowledge generated and codified in the world of 'science'.

## 7 Further points for discussion

This last section presents some further points for discussion concerning the theoretical and methodological aspects of the research, including a debate on the limitations of this research.

The first point for further discussion refers to a critique to the use of orthodox Political Economy of Skills – and its normative representation of TVET as a type of education exclusively focused on imparting skills within skill formation regimes (Busemeyer, 2015) – in comparative and international studies. Within this framework of analysis, TVET is exclusively considered as a key mechanism for equipping the workforce with the skills required for the "jobs of tomorrow" (Tether, Mina, Consoli, & Gagliardi, 2005). This research argues that the use of this orthodox approach can make it harder for researchers to perceive and identify other possible roles of TVET in innovation processes, including acting as intermediaries between companies and services, and providing technical expertise in the form of research and development activities. This can also help to explain why are there very few studies that seek to conceptualize the role of TVET and TVET graduates in innovation processes, especially considering the growing importance of the orthodox PES approach in the field of TVET research in the last decades.

This paper argues that the use of the critical discourse analysis approach is fundamental to investigate the semiotic aspect of different TVET policies, especially in the comparative and international perspective. This approach helps to overcome the normative vision of TVET as described in the orthodox Political Economy of Skills, as it opens a space for different voices, including the experiences in regions that are not historically considered within the framework of the PES. Along with this line, this approach con-

tributes to de-naturalization of the idea of TVET as a mechanism of skills formation and diffusion, which in great sense reflects better the TVET cultures of developed countries.

However, the way the CPE approach has been materialized and implemented requires further development to fully achieve its potential. This paper argues that there is a need for combining the Critical Discourse Analysis with other types of methods that are more appropriated to analyse aspects of structuration. As CDA is described as the main type of method of analysis within the CPE approach, it may corroborate to the criticism of CPE as too constructivist (Staricco, 2015; Jessop & Sum, 2017).

Likewise, with the use of the Critical Discourse Analysis, the type of data collected and analysed in this research can be mainly described as qualitative data (text) in the form of number of interviews and documents produced within the time span of 2011–2019. This, in part, creates important issues for the results of the research. For example, because CDA is more appropriated to be implemented in the analysis of a limited number of texts, this research did not include a greater number of documents or other social actors, such as Trade Unions, or individual companies. In further investigations, the inclusion of a broader number of data sources (including quantitative analysis), therefore, could be beneficial to better understand the challenges and social tensions within innovation and TVET policies.

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