INTERNATIONAL JOURNAL FOR INNOVATION EDUCATION AND RESEARCH
ISSN: 2411-2933

Journal URL: https://scholarsjournal.net/index.php/ijier

DOI: https://doi.org/10.31686/ijier.voll0.iss10.3947

Aspects of design management in the context of technological innovation centers

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Abstract

The organizational structure of the Technological Innovation Centers (NITs) integrates diverse and complex management routines that, in general, impact on the capacity of Scientific and Technological Institutions (ICTs) to effect the transfer of technology. In this sense, the NITs seek means and tools capable of assisting in the operationalization of these administrative processes. Among the various possibilities, this article brings, in particular, the conceptual approach to design management. Design management establishes recommendations for the use of design resources according to institutional goals. Based on this approach, the article aims to identify management activities within the NITs and their relationship with design management. To this end, a literature review was carried out to build the theoretical framework, a documentary research to survey the innovation policy indicators (Ministério da Ciência, Tecnologia, Inovação e Comunicação [MCTI], 2019) and application of a likert-type questionnaire in consultation with five technological innovation environments in the region Northeast of Brazil. The study is classified as applied research with a qualitative approach with an exploratory and descriptive objective. The research showed that despite the understanding of the potential of design to promote technological innovation, design management is not a practice systematically integrated into the management processes of the NIT. Subsequently, it was possible to present a set of propositions for the application of design management that support the combination of the essential and complementary activities of the NIT for the transfer of technology.

Keywords: Design management, Innovation management, Technological Innovation Centers, Technology transfer.

1. Introduction

The Technological Innovation Centers (NITs) had greater dissemination after the enactment of Law n. 10.973 (2004), known as the Innovation Law. The aforementioned Law, in its main essence, provides for incentives for innovation and scientific and technological research in the productive environment. In 2016, it was updated to Law n.13.243 (2016), known as the New Legal Framework for Science, Technology and Innovation in order to encourage the creation of a more dynamic innovation environment in Brazil (Brazilian Support Service for Micro and Small Enterprises [SEBRAE], 2018). Among other measures, the New Legal Framework: (1) established the formalization of Institutions, Scientific, Technological and Innovation (ICTs) of private initiative; (2) it authorized foundations to become NITs or ICTs, expanding the role of Technological Innovation Centers; (3) it reduced barriers to importing inputs used in research and development (R&D); (4) established rules for

the creation of innovation stimulus grants; (5) proposed relevant changes in the application and operationalization of the Law to limit legal uncertainty; and (6) sought to strengthen and encourage the participation of ICTs in innovative activities associated with the productive segment (Rauen, 2016).

The attributions of the NITs range from the implementation and management of the Innovation Policy (IP) within the ICTs, in addition to the responsibility to encourage the protection and evaluation of institutional intangible assets, their creations, licensing or any other form of technology transfer. All this together with dialogue activities with researchers and inventors, giving an opinion on the convenience of protecting and disclosing internal inventions, as well as monitoring requests for registration and maintenance of intellectual property titles obtained by the institutions to which they are linked (Brazilian Support Service for Micro and Small Enterprises [SEBRAE], 2018).

Therefore, the NITs reserve the role of legitimate interlocutors for the propagation of innovation within the academic environment, as well as between the ICTs and the private sector, for the promotion and commercialization of the innovation generated in the academic institution (Santos, Miranda, Nodari, Froehlich & Sena, 2020).

The innovation capacity of NITs concerns how institutions/companies explore from routine activities to innovative activities. In this sense, the concept of innovation is linked to the expertise of properly coordinating internal resources that allow selecting and supporting projects capable of bringing solutions to the most pressing problems of Brazilian society and, at the same time, seeking partnerships, knowledge, skills and tools in the external environment (Negri, 2017).

Converging concerns with the previous statement, the article aims to identify management activities within the NITs and their relationship with design management to strengthen the guidelines and objectives established by the ICT Innovation Policy. Therefore, it was necessary to reconsider the position of design, previously interpreted only as a task of developing new products, to move up to the strategic levels related to its administration (Franzato, 2011; Franzato and Celaschi, 2012).

To support the study, the following questions were proposed: in which managerial activities related to the Innovation Policy do the NITs keep busy? What is the technology transfer capacity of the NITs? What is the perception of managers about design management? How to organize the manifestations of design management according to the guidelines and objectives established by the ICT Innovation Policy?

2. Theoretical Foundation

2.1 Design management and innovation management for technology transfer

The achievement of responsibilities regarding the implementation of Innovation Policies imposed on the NITs is part of a larger system and depends on a set of activities and dynamic interactions incorporated in different dimensions of the organization. This system concerns the factors and intrinsic resources in the various dimensions of an organization, which range from management techniques and tools to organizational processes and routines, procedures and structures, reaching the principles and values of the organization (Figueiredo, 2006; Martins; 2013; Santos *et al*., 2020).

Several authors agree that it is important for the NIT manager to play a proactive role in devising strategies

that are consistent with effective management for the ICT innovation policy, through a continuous strategic planning project (Toledo, 2009; Somaya, Teece & Wakeman, 2011; Souza, 2011; Spivey, Munson & Wurth, 2014).

The term innovation management, within the scope of the NITs, refers directly to the processes of protection and licensing of technologies such as patent registration, trademark registration, software development and intellectual property. Innovation management refers managers to care for the ability to innovate with regard to extracting knowledge from routine activities and activities to explore innovation, management is understood as the organization's ability to identify needs, generate, capture, share, store, evaluate and select ideas for innovation (Pires M.; Santa Rita & Pires A., 2020).

In this sense, design management approaches innovation management, especially with regard to planning, in order to establish a project culture that allows approaching its tasks according to design assumptions, considering its strategic character (Mozota; Klöpsch & Costa, 2011).

The first signs of the emergence of design management (DG) date back to 1966, when the first prize in Design Management was awarded by the Royal College of Art. In 1975, in the United States, it was founded in Boston, by Bill Hannon, and by the Massachusetts College of Arts, the Design Management Institute (DMI), with the objective of promoting training in the area. In 1990, the London Business School published a collection of articles to discuss the contributions and role of design in the economy and in business. The DMI remains active, being one of the most prominent and active centers for the dissemination and dissemination of information on design management (Mozota, 2003).

The International Council of Societies of Industrial Design, a world organization of design professionals, and the World Design Organization (WDO) establish that design is an intellectual, technical and creative activity related not only to external characteristics but, above all, to with the structural and functional relationships that make an object (or a system of objects) a coherent unit, both from the point of view of its execution and from all aspects of the human environment conditioned in the project, involving a wide spectrum of knowledge and skills in a targeted and strategic way (International Council of Societies of Industrial Design [ICSID], 2021). At first glance, we understand the design linked to the sense of aesthetics and appearance and, secondly, it relates it to a set of procedures in the design aspect.

The design activity can be inserted into an organization through the Chief Executive Officer (CEO), corporate communications, research and development (R&D), production and marketing (Mozota; Klöpsch; Costa, 2011). As it is both a result and a process, it develops its educational background through applied and processing skills (Bruce and Harun, 2001 *apud* Mozota *et al*., 2011) (Figure 1).

Design Specialties	Knowledge of Design	Design Process	
Graphic design Product design Packaging system design Signaling system design (wayfinding) Information design (digital) Instructional design Textile design Environment design (internal and external) Service design Digital design (User Interface - UI) Interactive design (User Experience - UX)	• Process • Material • Marketplace • Technician • Commercial	Investigation	Idea
		Search	Concept
		Exploration	Choice of style, sketches, designs, templates
		Development	Detailing, technical drawings, 3D simulation, working capability
		Realization	Testing, prototype documentation
		Evaluation	Production, product/artifact configuration

Figure 1 – Specialties, knowledge and design process

The various especialties of design are considered as resources that create differentiation in the company's internal capabilities, that is, they are capable of implementing the culture of the creative process integrated into other processes of the organization, such as management of innovation ideas and development research (Mozota *et al*., 2011).

Seeking complementarities and overlaps between design management and innovation management from the conceptualization of terms in their areas of origin. In the administration area, it was possible to verify that one of the first connections refers to the fact that innovation management is evaluated as a process divided into phases or sub-processes, where organizations transform ideas into products, services or processes, whether new or improved, in order to to progress, compete and successfully differentiate themselves in their market niche (Baregheh, Rowley & Sambrook, 2009). In similar circumstances, design management focuses on designing products and services within strategies previously established by the corporation, fulfilling specific requirements both in the context and in the project, in order to act in the integration of the concept of the company's product portfolio and its commercialization. (Mozota *et al*., 2011).

Innovation management requires the coordination of the development of the portfolio of innovation projects in a clear and specific set, guided by a full strategy of the business vision (Flynn, Dooley, O'sullivan & Cormican, 2003). In this same perspective, Björk, Di Vivenzo, Magnusson & Mascia (2011) declared the importance of organizations in managing their ability to develop ideas and create new options and opportunities, aiming to secure their own future by exploring them in the business system.

The process of the "Innovation Spiral in design normally evokes continuity and recursion where it is possible

to associate its four main phases (research, analysis, synthesis and realization) in quadrants that subdivide these processes" (Cautela, 2007, p. 61). Design acts with centripetal force towards innovation, deforming the cycle of experiential learning, according to the spiral of innovation driven by design (Jonas, 2007; Franzato, 2011) (Figure 2).

In Phase 1, called Research, surveys must be carried out to support and enrich the project with relevant information. They are researches that involve the internal context: previous institutional history (identity, productive competences, intellectual capital, etc.), and its offer (product/service portfolio), production and delivery method, in its competitive performance context (market, target audience, communication, etc.) in the external context of the organization; the current market situation, trends and technologies, communication and positioning, stakeholders and other research related to the case such as political, social and environmental concerns as appropriate. These two types of research respectively of "contextual research" and "blue-sky research", one can also use quantitative and qualitative methods, from statistics to ethnographic studies and semiotic analysis. (Celaschi and Deserti, 2007; Cautela, 2007; Moraes, 2010).

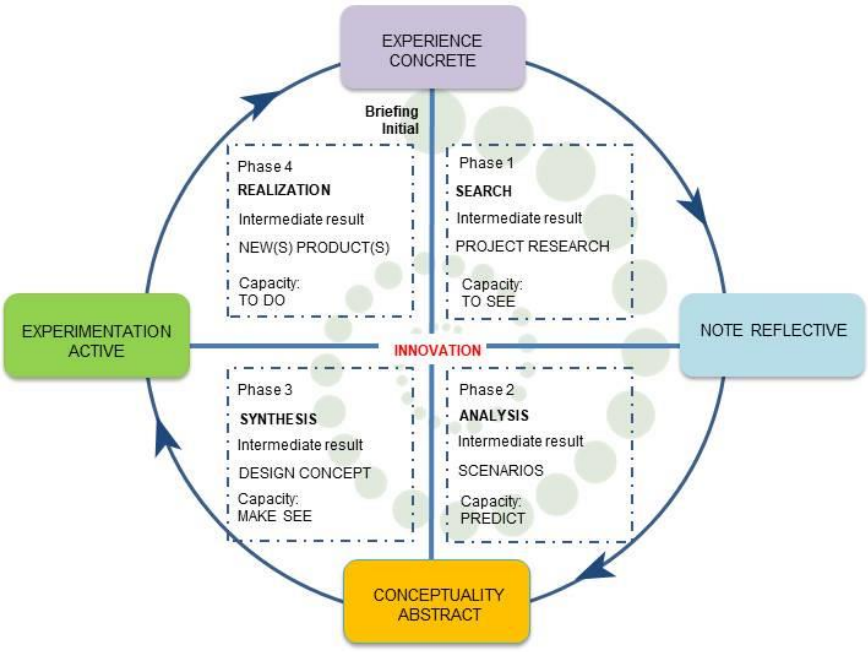

Figure 2 – Design-driven Innovation Spiral adapted (Franzato, 2011, p.53)

Phase 2 is properly analytical, that is, it should be considered an eminently synthesis activity. The data must be meticulously analyzed and reinterpreted to explore alternative contexts to the starting point, where new scenarios and new innovation trajectories will be envisioned. This phase only takes place within the process as a whole if the elaboration of the scenarios and the information collected serve to guide the choices and paths for the project and the elaboration of future scenarios.

Phase 3 is dedicated to the creation of design concepts, where innovative proposals are created and new products/services are generated. In this phase, designers usually express their ideas synthetically, giving form to them and modeling them virtually (Franzato and Celaschi, 2012).

In Phase 4, the project is implemented, requiring a plan of actions that need to be carried out by the company/organization to capitalize on the learning and reduce the risks of progression along a certain innovation trajectory (Franzato and Celaschi, 2012). The products receive technical details and prototypes are made, where, depending on the need, some are produced and marketed (acceptance tests). With the approval, the last step is the design of the visual communication, that is, creation of the brand and manual, packaging, instructional material, publicity material, exhibitor(s), catalogs, among others, as required by the project.

The Spiral of Innovation roadmap demonstrates the typical systemic character of design studies, conferring its transversality, that is, its ability to establish the relationship between the various aspects that make up the social, economic and cultural reality of the project, proposing, at the same time, time, a prospective strategic posture (Moraes, 2010).

For Centro Português de Design (Portuguese Design Center [CPD], 1997), the use of design in a company or institution is more than hiring the services of a designer or creating a design department, as it implies adhering to a new way of thinking about the activity. and integrate it globally into the company. In this way, design management goes beyond the field of developing new products and/or services, as it feeds back through research, analysis, synthesis and realization. In this form of Innovation Spiral, design thinking is strengthened within the organization and, especially in its own supervision, establishing a new paradigm for corporate innovation.

3. Methodology

The methodological course covered three consecutive moments, integrated during the research. In the first phase, a literature review was carried out based on books, theses and scientific articles. Based on secondary data, it was possible to build a theoretical framework that made it possible to explain the problem, help the construction of hypotheses and their analyses. The most relevant texts were selected, with practical applications on "management of technological innovation centers", "design management", "innovation management" and "technology transfer management". Due to the need for flexibility in considering the various aspects related to the data collected, the research is classified as applied, with a qualitative focus, with an exploratory and descriptive objective (MARCONI; LAKATOS, 2021).

In the second moment, the data collection was carried out, carrying out the investigation with a group of managers of NITs. As a resource for data collection, a questionnaire with a 5-point Likert scale was used, containing identification, description and theoretical explanation of phenomena. The questionnaire consisted of 10 indicators on essential activities for maintaining the routines of the NITs, required by the Ministry of Science, Technology and Innovations (MCTI) (Ministério da Ciência, Tecnologia, Inovação e Comunicação [MCTI], 2019). The research took place in January and February 2022, in four states in the northeast region of Brazil: Alagoas, Maranhão, Paraíba and Sergipe. Five managers participated in the study and represented a non-probabilistic sample. Also at this stage, information on the official websites of these institutions was analyzed and qualified and subsidized by non-participant observation.

The third moment of the research presents the possibility of organizing the manifestations of design management according to the guidelines and objectives established by the ICT Innovation Policy, through indicators

on essential activities (10 indicators) and complementary (12 indicators) required by the Ministry of Science, Technology and Innovations (MCTI) (Ministério da Ciência, Tecnologia, Inovação e Comunicação [MCTI], 2019).

4. Analysis and discussion of results

The researched innovation environments, in the northeast region of Brazil, started the activities of NITs as soon as the first version of the Innovation Law n. 10.973 (2004). The characterization of the group in terms of profile, time of existence and stage of implementation of Innovation Policies is shown in Figure 3.

It can be seen that 4 of the 5 respondents declared that they were in the process of implementing innovation policies, in line with the situation of most NITs in the Brazilian territory (Ministério da Ciência, Tecnologia, Inovação e Comunicação [MCTI], 2019).

Identification NIT/ICT	Innovation Environment	Time of existence of the NIT	Stage of implementation of Innovation Policies
NIT 1	Public Institution	16 a 20 years	In process of implementation
NIT 2	Other	16 a 20 years	In process of implementation
NIT 3	Public Institution	11 a 15 years	In process of implementation
NIT 4	Public Institution	11 a 15 years	In process of implementation
NIT 5	Public Institution	11 a 15 years	Implemented

Figure 3: Characterization of the institutions participating in the questionnaire

Managers were asked how often they work with the ICT Innovation Policy, using 10 questions from the form as a basis for information on the "essential activity of the NIT" according to Table 1 (Ministério da Ciência, Tecnologia, Inovação e Comunicação [MCTI], 2019, p. 24).

Table 1 Essential Activities performed by the NITs in relation to IP and the transfer of Technology

Most performed actions in NIT activities in relation to IP and Technology Transfer (TT)					
Affirmations	**Never**	**Rarely**	**Sometimes**	**Often**	**Ever**
Monitor the processing of requests and maintenance of IP titles	0	1	0	1	3
Ensure the maintenance of the institutional policy to encourage IP protection	0	0	1	0	4
Opinion for the convenience and promote the protection of creations developed in the institution	1	0	0	1	3

Opinion on the convenience of disclosing the creations developed in the institution	0	1	2	1	1
Promote and monitor ICT's relationship with companies	0	0	0	3	2
Evaluate and classify the results arising from research activities and projects	0	0	2	2	1
Evaluate an independent inventor's request for invention adoption	0	1	2	0	2
Negotiate and manage ICT technology transfer agreements	0	2	0	1	2
Develop studies of technological prospection and competitive intelligence in the field of IP	1	2	1	1	0
). Develop studies and strategies for the transfer of innovation generated by ICT	1	1	0	3	0

With regard to data collection, it was noted that the statement "To ensure the maintenance of the institutional policy to encourage IP protection" appeared more frequently (80%), characterizing it as one of the most requested activities by the ICT.

Subsequently, with 70%, the statements "Monitor the processing of requests and maintenance of IP titles" and "Opinion for convenience and promote the protection of creations developed in the institution" appeared among the activities most performed by the NIT.

Regarding the factual analysis regarding these data, it was found that university-company partnerships are, for the most part, resulting from the business demand for a technology developed at the university. It was found that, most of the time, management is concerned with maintaining existing relationships and also with conserving or depositing patents.

When asked about "Opinion about the convenience of disclosing the creations developed in the institution", the answers were more diversified. However, all managers stated that, in a way, they seek to give an opinion, demonstrating a predisposition for proper guidance. On the other hand, it was noticed that there is no search or request for this type of intervention or support by most of the academic community, indicating a certain lack of knowledge about the role of the NIT or, still, the lack of maturity of a culture of innovation.

Another statement analyzed in favor of the innovation policy was "Promoting and monitoring the relationship between ICT and companies". The answers showed the concern with university-company interaction, which is a priority over other activities, often reinforced through personal contact of researchers and/or research groups with possible interested companies.

About "Evaluating and classifying the results arising from research activities and projects", 40% of managers see the statement as a sporadic activity, while the others (60%) as an activity carried out according to demand.

A question that divided the managers' position referred to "Evaluating an independent inventor's request for

the adoption of an invention", the questioning referred to the willingness to meet any person/inventor who meets the criteria established by the patentability standards: novelty, inventive step and industrial utility (Ministério da Ciência, Tecnologia, Inovação e Comunicação [MCTI], 2019). Under these conditions, the provision of guidelines and follow-up of the patent application to the INPI occurs via direct consultation of the inventor with the NIT. With regard to this issue, it was observed that this situation appears more intensely for one of the NITs and as a non-regular activity for the rest of the group.

Then the task "Negotiate and manage the technology transfer agreements from the ICT" reflected the movement of the transfer contracts from the NIT. Two managers (40%) declared it as a constant activity, one (20%) as a sporadic activity and the others (40%) as a rarely performed activity. This result demonstrates that there is a very diversified orientation in managerial operations.

The item "Developing technological prospecting and competitive intelligence studies in the field of IP" proved to be the most fragile, although one of the NITs declared it to be regularly practiced (20%). This question revealed that there is some difficulty in selecting companies to develop projects in partnership with ICT researchers (80%).

Finally, regarding the statement "Develop studies and strategies for the transfer of innovation generated by ICT", the answers indicated two sets among the respondents where, part never or rarely performed such activity (40%) and part (60%) has as almost routine operation. This survey suggested the existence of a management busier with the legal and bureaucratic procedures of the technology transfer process, while another more attentive to the possibilities of the business context.

In order to verify the routine actions in relation to the effort to meet the prerogatives of the ICTs' innovation policies, the demand for such information from the external community was considered. For this, institutional websites were consulted.

The verified sites mostly presented content about: (1) about the innovation unit, objectives and configuration of the centers (team and contacts); (2) documents, forms, legislation, standards, confidentiality policy, model contracts, declaration of invention, IP manuals and guidelines; (3) external partnership links; (4) research and orientation groups and activities for researchers, register of researchers; (5) monitoring of ICT research activities; (6) registration and provision of training; (7) programs and notices to support research and scholarships; (8) Registration of researchers, junior companies and incubators and (9) extension activities and calendar of events.

Among the information not found, the following stand out: (a) product portfolio and/or offer of technologies for exclusive licensing; (b) supply and demand register, (c) services of economic evaluation of inventions and (d) disclosure about participation in the capital stock of companies.

The NITs were also analyzed in terms of intellectual property deposits (Table 2), with the objective of mapping and identifying the types of intellectual property that represent the greatest number of records.

Table 2: Total intellectual property deposited by the evaluated NITs

Amount of intellectual property deposited by the NIT/ICT and/or by companies supported	Total intellectual property deposited
1. Invention patents	846
2 Computer program	297
3. Brands	93
4. Copyright	64
5. Cultivars	22
6. Industrial Draw	7
7. Related rights	0
8. Geographical Indication	0
9. Integrated circuit topography	0
10. Traditional Knowledge	0

Data collection indicated that there is a tendency and/or preference to apply for invention patents and computer program registration by innovation units, either because of their vocation in relation to prominent basic research in academic environments, or because of incentives from current notices. It was observed that eight of the ten modalities are distant in quantity from the first and second places in the list. Some modalities scored very little, such as trademarks, copyright, cultivars and industrial design, or even scored, leaving open precisely areas that are linked to the cultural industry and creative economy.

Although the units surveyed have been in existence for more than ten years and are located in the northeast region, the centers pointed out some disparities between them in terms of the amount of industrial property deposited by the NIT/ICT. Two of the units stood out in the total number of patents filed. Despite the documented commitment to the activities carried out by managers, the numbers presented are very far from the numbers that a few NITs in the south and southeast region present (Ministério da Ciência, Tecnologia, Inovação e Comunicação [MCTI], 2019). This fact corroborates with Toledo (2009) and Machado and Sartori (2015), citing that most Brazilian NITs are still in an embryonic stage of evolution, with few protected technologies and few technology commercialization contracts concluded.

Studies reveal that, over the years, NITs still need to develop organizational skills both in terms of their functional responsibilities and the development of strategies for technology transfer and innovation management in their ICTs. The above argument indicates an embryonic stage of Brazilian NITs, with few protected technologies and few commercialization contracts (Toledo, 2009; Lotufo, 2009, Chimendes, 2011; Machado; Sartori, 2015).

The research registered the managers' concern to seek an action aimed at offering the technologies available in the ICTs, as well as the willingness to show a greater openness to the creation of partnerships and discussion with the productive sector. Some actions are being planned, such as the creation of technological showcases (use of the electronic address to display a technological portfolio with a view to formalizing and/or enhancing

dialogues) or permeate in the form of awareness-raising at institutional moments, meetings and other opportunities for meeting and/or contact between the parties.

Subsequently, the perception of managers regarding the competences of design management to collaborate in the management process of NITs was investigated. Managers were exposed to four statements, not completely disagreeing with any of them, indicating that they somehow take into account design contributions (Figure 4).

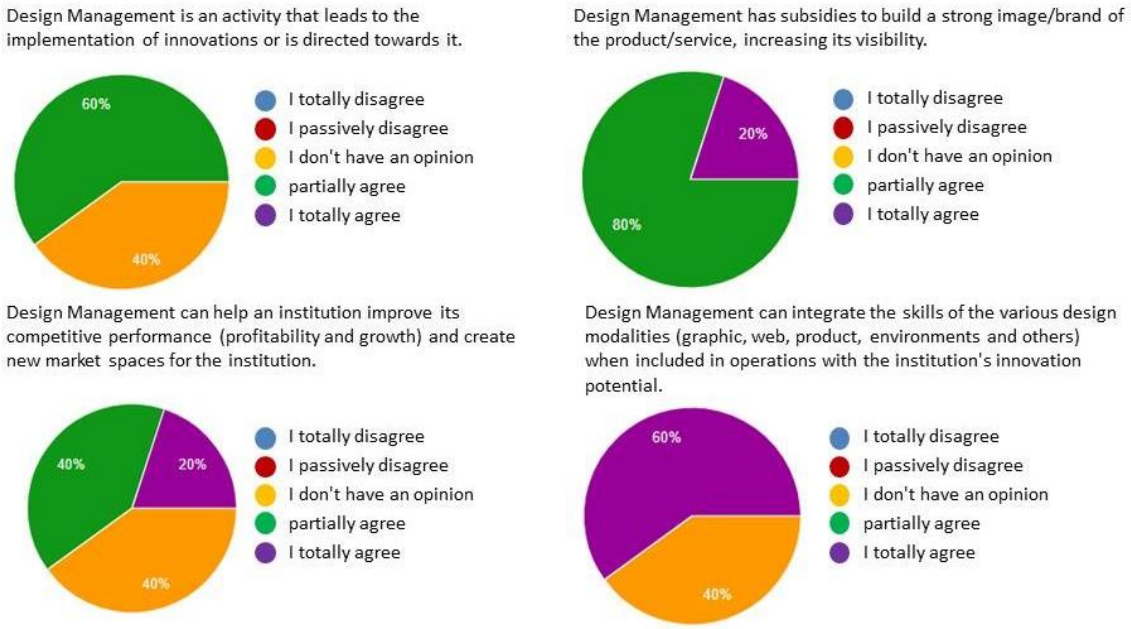

Figure 4 - Unit managers' perception of Design Management

The first statement, “Design management is an activity that leads to the implementation of innovations or is directed towards it” was considered as partially true by most managers (60%), which demonstrates an uncertainty about the design being totally focused on innovation. and/or be responsible for its implementation.

In the alternative “Design management can help an institution improve its competitive performance (profitability and growth) and create new market spaces for the institution” there was agreement on two occurrences, I partially agree and I have no formed opinion (40%), and one occurrence for partially disagree (20%), leading to the understanding that this statement is fragile and unreliable for the researched group.

The statement “Design management has subsidies to build a strong image/brand of the product/service, increasing its visibility” was the one that aroused the greatest disbelief in the group of managers, with four responses I partially agree (80%) and only one I totally agree (20%).

In the last exhibition, “Design management can integrate the skills of the various design modalities (graphic, web, product, environments and others) when included in operations with the institution’s innovation potential”, there were two responses (40%) for no I have a formed opinion and three (60%) totally agree, indicating more agreement with regard to design management and its competencies.

The data showed that design management still represents a new theme within the context of innovation centers.

Despite the recognition of some aspects of design by managers, there is not complete confidence in the capabilities of design management to leverage competitiveness and, in addition, there is little recognition of the possibility of increasing it as an ally to execution and management of the implementation of the Innovation Policy in ICT.

From this moment on, the research turned to an approach on aspects related to design management with the concern of meeting the guidelines and objectives established by the ICT Innovation Policy (Ministério da Ciência, Tecnologia, Inovação e Comunicação [MCTI],2019). These Innovation Policies aim to develop mechanisms that facilitate the connection between holders of knowledge and those interested in its application in productive environments.

The path from the creation of knowledge, through technologies and ending in new products and services for the community, characterizes, in a simplified way, the flow of technology transfer in three major phases (Figure 5).

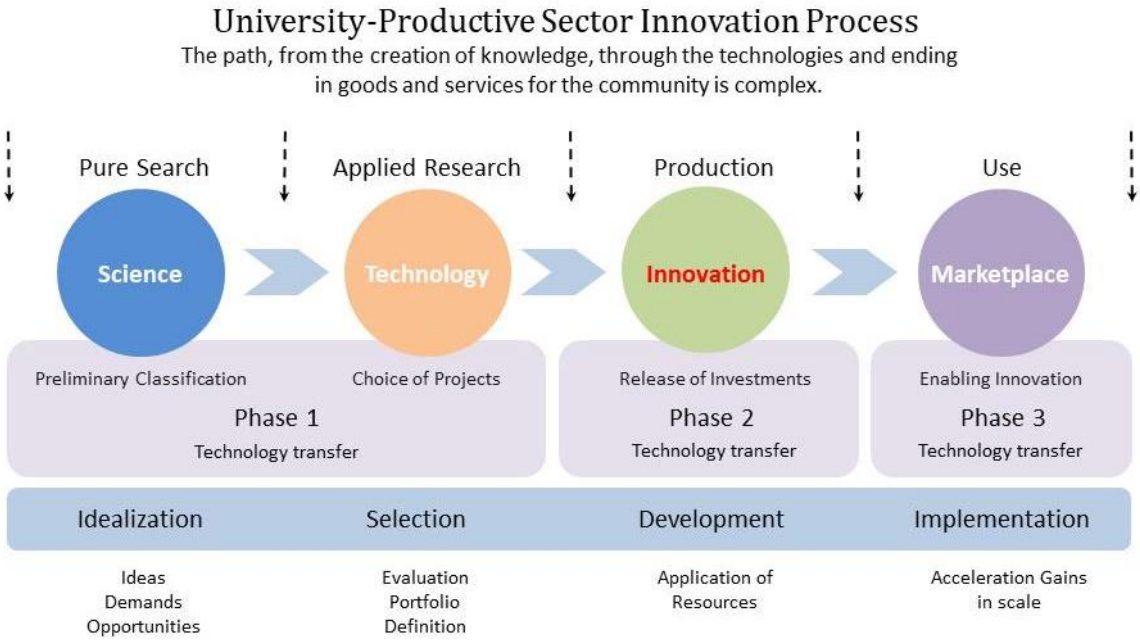

Figure 5 - Technology Transfer Flow

Every innovation process goes through different phases: science, technology and design. When a link is missing in this chain, innovation has no economic and social resonance. When science separates from the other two stages, we arrive at academicism, and when we isolate technology we arrive at technocratism. When we treat design separately, we run the risk of falling into the trap of aesthetic formalism. design is the last element in the chain through which scientific and technological innovation is introduced into the practice of everyday life. “That is why design contains considerable potential when it is integrated into scientific and technological research institutes.” (Bonsiepe, 1997, p.38).

The typical project vision of design management as presented by Espiral da Inovação do design confers transversality in the internal dimensions of the organization and, through its competences, is able to establish the relationship between the various aspects that make up the social, economic and cultural reality of the

project, proposing, at the same time, a strategic and prospective posture for the institution (Moraes and Krucken, 2008).

When the institutional goal is directed towards innovation, design through its management can be considered a tool that creates differentiation in the company's internal capabilities, that is, it presents a creative management process integrated with other processes of the organization, such as idea management innovation and development research (Mozota *et al*., 2011).

Figure 6 represents a circular structure that helps to understand the proportions that design management has acquired along with the flow of innovation for technology transfer. The three phases of innovation can be connected to the model by Mozota *et al*. (2011) that describes design competencies as coordinator, differentiator and transformer.

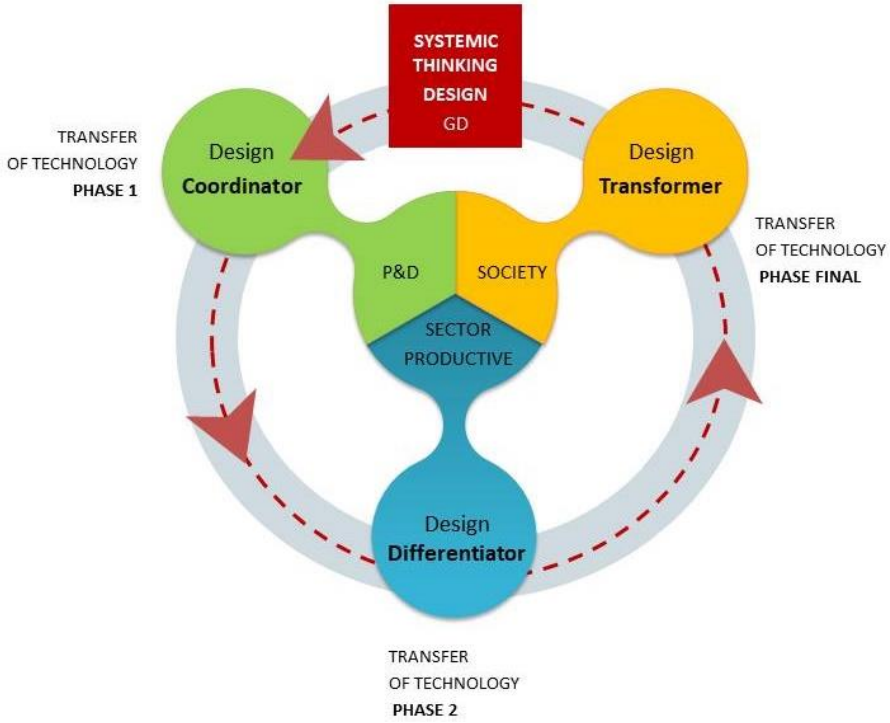

Figure 6: Scheme of design management for value creation in technology transfer

The form of active technology transfer that is characterized when a person, or a group, has the responsibility to verify the feasibility of using a certain technology, that is, the ability to meet market needs (Braga, 2009). This means that it is not enough for managers to be concerned only with the identification of ideas, but also to assume a proactive role of stimulating the formulation of ideas and creating new options and opportunities, aiming to guarantee their own future by exploring them in the system of business (Björk *et al*., 2011).

As for the internal organizational structure of the routines performed by the NITs, it is important to integrate the activities, since the greater the systematization of organizational processes, the more effective the results generated will be (Costa and Porto; 2014).

To demonstrate the conceptual relationships with design management, these activities needed to be previously defined, organized and combined in a certain logical order. First, the 10 indicators of essential activities were

listed and the 12 indicators of complementary activities were added (Ministério da Ciência, Tecnologia, Inovação e Comunicação [MCTI], 2019). Then, the requirements set out in the guidelines and objectives established by the Innovation Policy for ICTs (Ministério da Ciência, Tecnologia, Inovação e Comunicação [MCTI], 2019) were listed. In the sequence, the three sets of actions for the management of the design that represent the manifestations of the coordinating design were ordered; differentiator and transformer, which are described in Mozota's theoretical constructs; Klöpsch and Costa (2011) and, now adapted to the reality of ICTs.
Figure 7 represents the manifestations of coordinating design that appear in Phase 1 of technology transfer; behind the function of managing change in the innovation process from research, development and innovation (RD&I), creating value by avoiding conflicts and improving communication between stakeholders. In this first sphere, where technology transfer begins, design is linked to the institution's internal processes and also to the management of innovation oriented to economic, social and environmental concerns brought about by research.

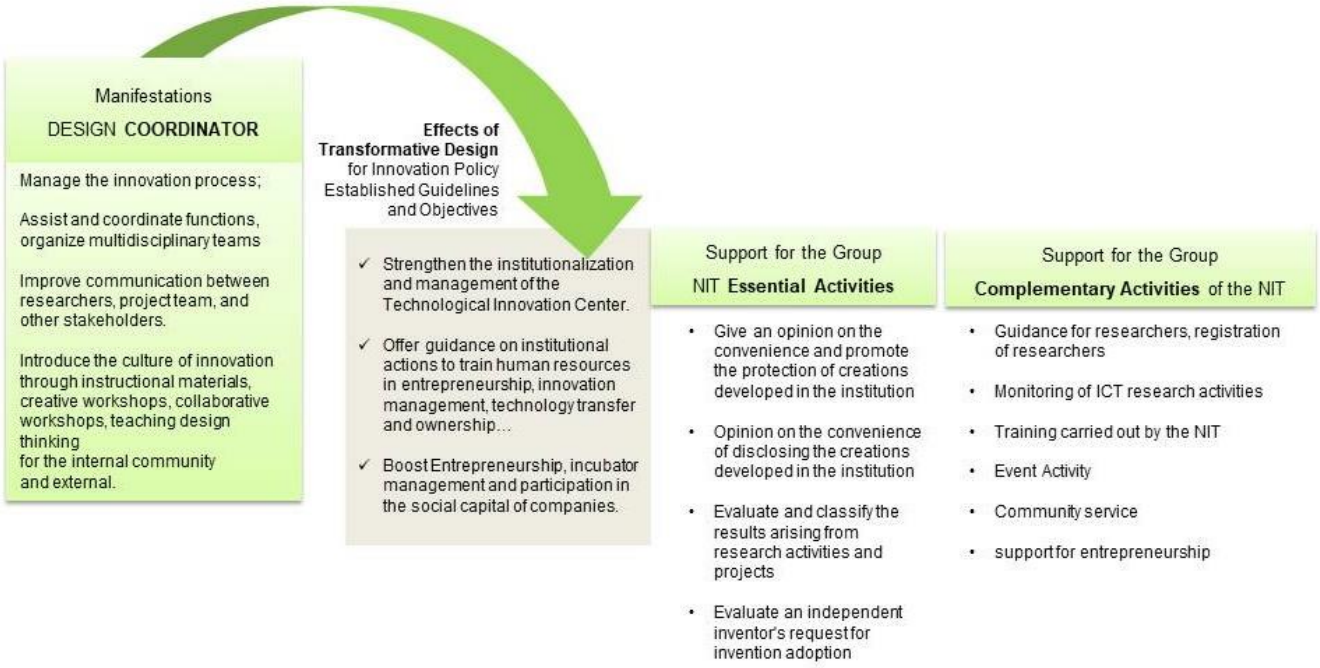

Figure 7: Coordinating Design: manifestations of design for established guidelines and objectives

In Phase 2 (Figure 8) of technology transfer, the differentiating design increases the financial value of the innovation as it improves performance or creates new products/services, inserting into them functional, aesthetic and symbolic values perceived by the market/society. At this moment of technology transfer, the manifestations of Differentiating Design increase the financial value of innovation as it improves performance or creates new products/services, inserting functional, aesthetic and symbolic values perceived by the market/society into them.

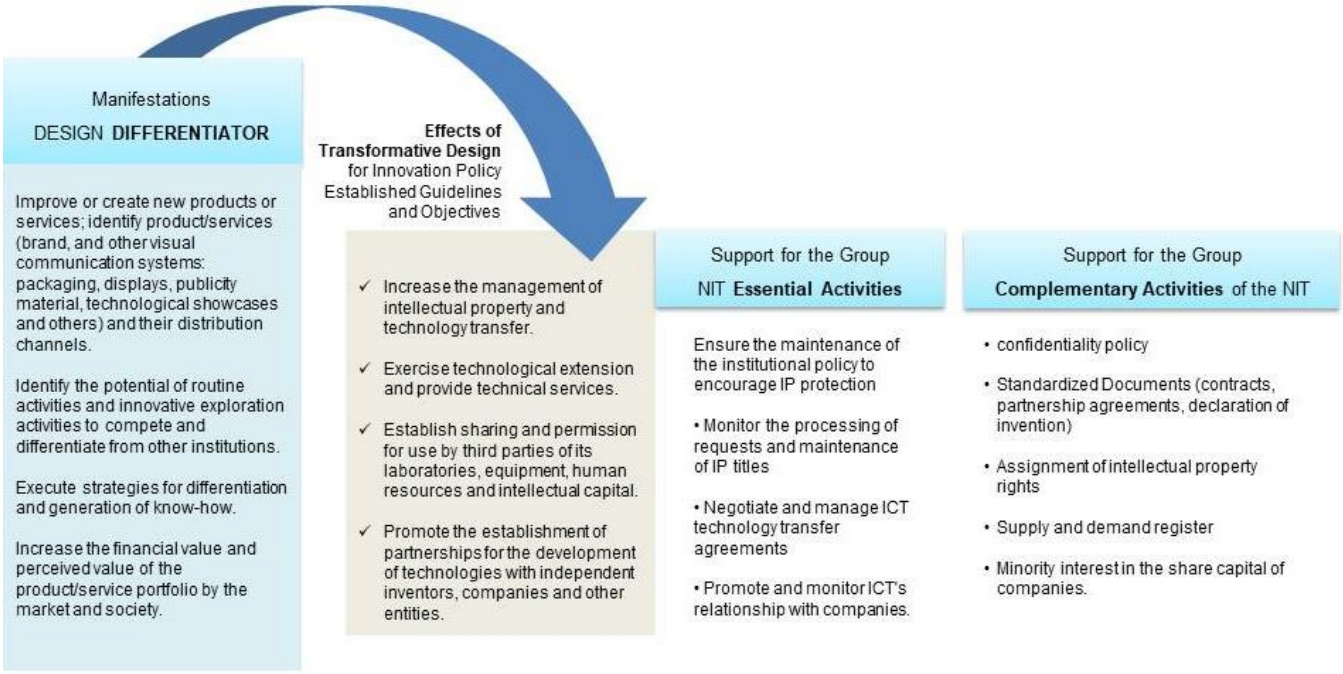

Figure 8: Differentiating Design: manifestations of design for established guidelines and objectives

In the final (Figure 9) stage of technology transfer, transformative design generates strategic value, delivering innovative products/services from a vision of future markets and, at the same time, creating trends, which contributes to the recognition of the culture of innovation in the institution.

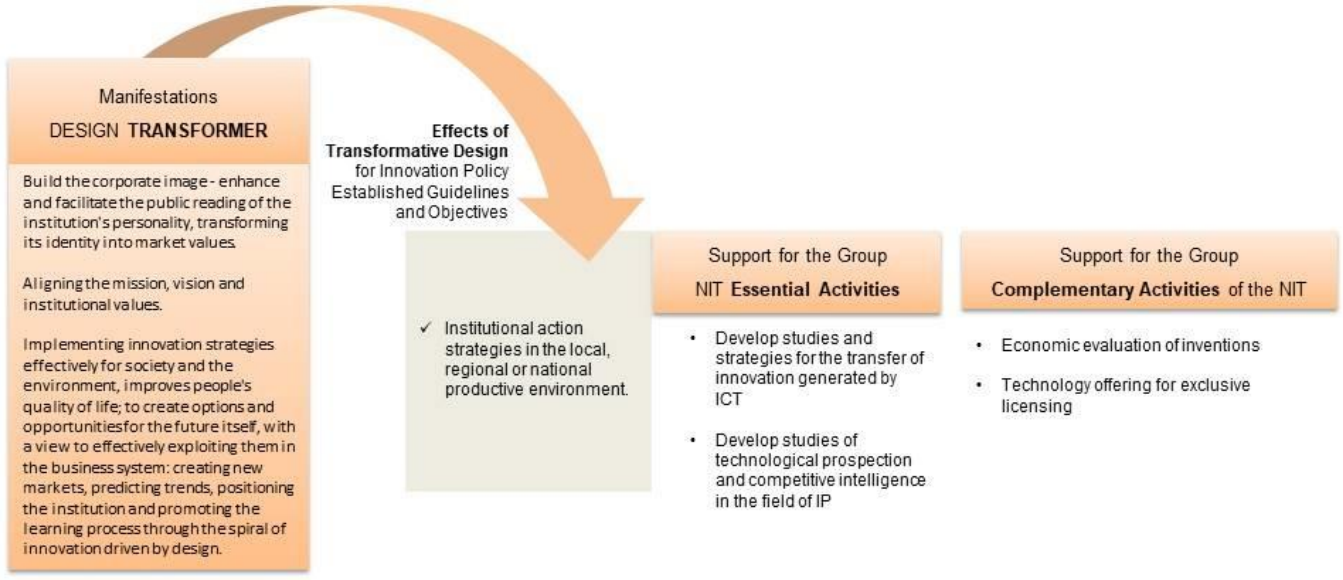

Figure 9: Transformative Design: manifestations of design for established guidelines and objectives

The design management approach has a systemic character necessary to adequately manage the set of activities developed by the NIT. It is possible to demonstrate design as a "formalized program" of activities within the company/institution by communicating the relevance of design to long-term organizational goals and coordinating design resources at the business activity level to achieve organizational goals (Mozota, 2003, p. 71).

It is worth remembering that for the organizational implementation of the NITs, there must be a commitment on the part of the leaders of the ICTs, creating a commission formed by people with the necessary skills provided for in the legal frameworks and expected attributions (Vailati, Trzeciak & Coral, 2012). It is believed that in the same way, the insertion of design management in organizations requires awareness, commitment and support from top management.

5. Conclusion

Part of the research sought to understand the level of perception of NIT managers on design management and analyzed the actions of the NIT in what concerns the management of essential and complementary activities for the fulfillment of the ICT Innovation Policy. The level of perception of NIT managers on the use of design management in managerial activities to promote innovation and technology transfer is incipient. On the one hand, managers demonstrated that they recognized the potential of design in specific activities but did not directly relate it to the flow of innovation for technology transfer.

As for the analysis of the management of essential and complementary activities for the fulfillment of the ICT Innovation Policy in these centers, it became apparent that the activities that stood out most relate to legal procedures, formalization and maintenance of the institutional policy to encourage the protection of IP in ICT and the mediation of already established partnerships. It was found that these activities demand a lot of operational time and are not directly related to the prospection of new partnerships and new markets. The activities that stood out the least concern the studies of technological prospection and competitive intelligence in the field of IP, together with actions that seek to develop strategies for the transfer of innovation generated by the ICT. These activities are precisely those of a strategic nature and which have greater adherence to the establishment of partnerships.

On the institutions' websites, it was possible to identify actions to promote innovation and entrepreneurship by offering courses and events with the participation of the internal and external community. Also the dissemination of programs and public notices to support research, work developed with incubators and technology licensing. This showed that managers feel the need to dedicate efforts to the activities of educating both the internal and external community regarding the culture of innovation.

As for the protection of intellectual property, invention patents appeared as the main form of assistance, but the number of licensed technologies is still small in the face of patent deposits, demonstrating that, despite their managers envisioning the strategic role of these centers, especially in what Regarding the opening of the university to relations with society, the NITs are still in the process of structuring. Another important finding was that the NITs are focused on patent protection, with the occurrence of other types of protection being much lower.

From this point on, the research moved towards the conceptual approach of design management for technology transfer. In a systematic way, the theoretical constructs of design management were formalized in three sets of design manifestations: coordinating design; differentiating design and transformative design. The manifestations of design were combined with the essential and complementary activities of the NIT and, at the same

time, incorporated the concern with external instances for the valuation of innovation in the course of technology transfer. In this way, design management was presented as a possibility to generate the necessary synergy between the essential and complementary activities related to the internal routines of the NITs and to value the entire technology transfer process, starting with the way of thinking about innovation management within the institution itself.

The article achieved its objective of organizing a set of propositions for the application of design management in the context of NITs using the scenario of four units located in the northeast region of Brazil and presented the partial result of an ongoing research, in which it is intended to continue investigating the applicability of design management and its consequences in the process of managing innovation and technology transfer.

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