

# The Role of Universities in the Innovation Systems in the Developing Countries

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## Abstract

There are no universal rules for improving the contribution of universities to the development of regional innovation systems. Much depends upon the context of the country, resources of a specific region and socio-cultural specifics. This article explores the given topic using the example of a technological university in India, located in a large region with established traditions and a culture of production. In the

implementation of the third mission of the university, a special proxy-organization played a key role, providing effective communication between stakeholders, the involvement of different segments of the population in the innovation system and joint development of technologies. The authors propose an interactive model that allows universities to develop new technological solutions for enterprises.

**Keywords:** third mission of universities; regional innovation system; strategies; new technologies; economic development; textile industry; technological university; local communities; entrepreneurship; India.

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## Introduction

In recent years, there has been growing interest from various parties - the educational and research communities, as well as the public sector - in the implementation of the third mission of universities - the production and use of knowledge to stimulate socio-economic development (Johnston, Wells, 2020). A number of empirical studies have been carried out in this direction, most of which were carried out based on the material of developed countries, in which universities are the key producers of knowledge and innovation (Benneworth et al., 2009; Trippl et al., 2015; Acosta et al., 2016; Martin, Trippl, 2017). However, the impact of universities on regional economies in developing countries has not yet been sufficiently studied (Thomas, Pugh, 2020). Using a variety of approaches, universities integrate all segments of the population into innovation systems, offering each group its niche (Grobbelaar et al., 2017). In developing economies, it is crucial for universities to collaborate with rural traditional industries that rely on less sophisticated technologies and encounter significant obstacles in acquiring technologies (Theodorakopoulos et al., 2012; 2014). Sánchez Preciado et al. (2016) state that low and intermediate technologies are simple and less expensive than advanced technologies imported from developed economies. However, the mechanisms of such transfers and the interactions of its participants have not yet been sufficiently studied. Universities find it difficult to maintain a balance between the commercial and non-profit components of their activities. The increase in the commercialization of knowledge makes universities inclined toward university-industry networks, undermining university-community networks and neglecting the social elements of innovation. The transfer of knowledge to industry has been studied in some detail, but the same cannot be said about universities promoting local communities (Jacobs et al., 2019).

Our article fills this gap by showing how a technical university can expand opportunities for local community involvement in small businesses.<sup>1</sup> The focus is on assessing the role of the Indian Institute of Technology Guwahati (IIT Guwahati) in developing the innovation system of north-eastern India through the transformation of small businesses. We are talking about the development of the textile industry. This case is of interest because the Institute was founded on the demand of local communities to foster academic excellence in the region, which would influence the creation of new jobs (IIT Guwahati, 1999). Indian Institute of Technology (IITs), in comparison with other national universities, have a high degree of autonomy and actively establish connections with industry (Datta, Saad, 2011). There are growing expectations from the government and business in terms of enhancing the transfer of

knowledge and technology by IITs into the economy and society (Krishna, Chandra, 2009). For this purpose, an intermediary organization has been created at the university - Rural Technology Action Group-North East, (RuTAG-NE) to promote the development of the regional economy by introducing scientific and technological developments into traditional industries (Saha, Ravi, 2019).

## Literature Review

### *Regional Innovation Systems*

A regional innovation system (RIS) studies the social interaction of local actors governed and guided by trust, responsibility, exchange, and cooperation (Cooke, 1998). RIS consists of two subsystems (Tödtling, Trippl, 2005). The first is responsible for research and knowledge generation in public research and technical institutes and universities. The second relates to the use of knowledge by local businesses, suppliers, and consumers. An important role in the development of RIS is played by the presence of dynamic research organizations, universities, and clusters and their effective communication among themselves and other actors (Karlsen et al., 2017).

In the last two decades, the role of universities has expanded (Marques et al., 2019) through the intensification of a third mission in response to the growing expectations of the government and society regarding the contribution of universities to innovation and economic development at the regional level (Salomaa, Charles, 2021). The concepts of the entrepreneurial, civic, and engaged university and the triple helix model have been developed to describe and stimulate this trend.

The functions of universities are viewed in terms of four key components of RIS: associative governance, regional agglomeration, human capital formation, and regional cultural norms (Gunasekara, 2006a). Within the framework of RIS, there are two main roles of universities - generative and developmental, which complement each other. The first involves the capitalization of knowledge in the course of cooperation with industry and the government to develop innovative strategies (implemented in firm formation/spin-off). The second has a long-term orientation and is to support social development through participation in regional networks and building institutional and social capacity. Developing a general methodology for assessing the contribution of universities to regional economic development is difficult due to the specific nature of public policies and education systems in different countries (Gunasekara, 2006b; Marques et al., 2019). Their contribution to regional development is determined by a number of factors, primarily territorial specificity,

<sup>1</sup> Family-run weaving and handicraft industries play an important role in India's regional economy. Despite this, they are characterized by insufficient capital costs and a lack of advanced equipment. Limited attention is given to this industry in the science & technology policy and it continues to operate in the informal sector.

the type of university (Boucher et al., 2003; Kohoutek et al., 2017), the institutional environment, the structure of the regional economy, and the strategic orientation of the university (Gunasekara, 2006a).

### ***The Contribution of Universities to the Development of Small Businesses***

Universities traditionally focus on developing international academic connections, while losing sight of another important function that they are expected to perform - the involvement of local communities in the socioeconomic system (Robinson, Hudson, 2013). The informal economic activities are often disconnected from the knowledge and innovation generated by universities (Gastrow et al., 2017).<sup>2</sup> The question arises: how can universities reverse this situation? The role of universities in integrating local communities into institutionalized innovation networks has not yet been sufficiently studied. In implementing their third mission, universities use various intermediary organizations (Villani et al., 2016) to transfer and diffuse technologies, organize and coordinate information flows, search for partners, and adapt existing solutions to user needs (Howells, 2006). Similar proxy structures, such as technology transfer offices and regional innovation agencies, form a space for cooperation and consensus among participants in regional innovation systems (Fernández-Esquinas et al., 2016). Despite the growing number of studies on such organizations, a substantial effort is still required to understand their role in knowledge transfer for traditional industries.

Our article contributes to the management of universities' roles in societal and economic development. Using the example of the textile sector of the North-East region of India, the influence of IIT Guwahati is explored through the proxy structure of RuTAG-NE on the development of traditional crafts, mechanisms for knowledge exchange and co-creation activities, and the main actors in this process are revealed.

### ***Technological Transformation of the Textile Sector***

Before moving on to the case of IIT Guwahati, it makes sense to look at how innovation at the forefront is changing the face of the textile sector in the world today. The textile industry is embracing digitalization, advances in materials science, and advanced manufacturing technologies to efficiently produce clothing using sustainable and ethical methods. New technologies are modernizing traditional textile production, giving new impetus to the development of related sectors, and expanding its potential to increase its contribution to the national GDP. With the advent of new technolo-

gies, the variety of types of fabrics, materials, textiles, and their areas of application is expanding.<sup>3</sup> The concept of sustainable textile production is being introduced, which involves minimal energy use in production and the possibility of recycling products at the end of their life cycle. There is a trend towards increasing the availability and economic efficiency of environmentally friendly textiles. Examples of eco-friendly technologies include fabrics made from bamboo and recycled waste. The technology of creating customized textiles is gaining momentum, allowing the customer to remotely select or create various designs and print them on fabric. Smart computerized looms allow you to quickly create complex patterns, laser scanners and computers create finished patterns without cutting the fabric itself.<sup>4</sup>

The possibilities for producing raw materials for fabrics are expanding. So, in 2023, a discovery was made - using genetic engineering it is possible to produce spider silk.<sup>5</sup> New advanced materials improve the functionality of textiles and introduce a "smart" component. In advanced laboratories around the world, clothing is being developed from robotic fabrics that act as external muscles. It functions as a soft exoskeleton, increasing the freedom of movement of people who have difficulty walking, and also provides a dynamic massage, improving blood circulation in the human body. This technology has a biomimetic basis, reproducing the hygroscopic movement of plants, and the source of energy is the heat of the human body itself.<sup>6</sup> Developments are underway to produce environmentally friendly fabrics from seaweed and crustaceans, which also have anti-inflammatory properties. Smart clothing based on ion-conducting fibers is gaining popularity; it performs thermal regulation functions, can automatically change color and, if necessary, turn on a reflective option, while also exhibiting durability.<sup>7</sup>

Along with aesthetic textiles, the Government of India is also promoting technical textiles, which have been in high demand in recent years.<sup>8</sup> Due to its return on investment, versatility, sustainability, and durability, the demand for technical textiles has skyrocketed on the global market. In order to position the country as a world leader in the field of technical textiles, the Government of India has supported its production with a view to application in wide areas such as agriculture, transport, medicine, infrastructure, clothing production, and so on. These trends can be a guide for universities in developing countries that have textile clusters and human capital with high motivation to transform their region into a thriving economic hub that can gradually embrace increasingly sophisticated technologies and development models.

<sup>2</sup> The informal economy can be defined as economic activity that falls outside the scope of government regulation. This includes both the informal sector and informal employment in the formal sector.

<sup>3</sup> <https://www.startus-insights.com/innovators-guide/textile-industry-trends/>

<sup>4</sup> <https://www.linkedin.com/pulse/technology-innovation-textile-sector-eastman-exports/>

<sup>5</sup> <https://www.newscientist.com/article/2392737-silkworms-genetically-engineered-to-produce-pure-spider-silk/>

<sup>6</sup> <https://www.startus-insights.com/innovators-guide/textile-industry-trends/>

## Case Analysis

### *Northeast Region (NER)*

The region in question includes eight states: Tripura, Manipur, Sikkim, Assam, Mizoram, Nagaland, Meghalaya, and Arunachal Pradesh, and is characterized by linguistic and cultural diversity. A total of 45 million people live here. The economy of the NER is dominated by agriculture and the share of industry is insignificant (Sachdeva, 2000). Due to the slow pace of industrialization, surplus labor is concentrated in the agricultural sector without access to alternative sources of income (Hussain, 2004). The region's industrial development prospects are limited due to its landlocked nature (Bhowmik, Viswanathan, 2021). In order to change this situation, the Government of India has included infrastructure and industry development in the list of government priorities (Das, 2017). To develop the NER, a special ministry- the Ministry of Development of the North Eastern Region (MDoNER)-was created in 2001 to develop, implement and evaluate the results of relevant programs.

### *Textile Sector*

Weaving and handicrafts, which are essential elements of textile making are practiced in all states of the NER, besides the commercial one, have a cultural dimension that contributes to the preservation of historical heritage (in some parts of the region it has been practiced since the pre-colonial period) (Dikshit, Dikshit, 2014). The sector is seen as a potential source of economic growth (the region's five states account for about 60% of the country's total handloom capacity) and roughly the same proportion of households are employed in it and related activities. The state of Assam holds a special position as it produces four different types of natural silk (Goswami, 2009). Micro-entrepreneurs lack awareness of copyright protection mechanisms such as *geographical indication*, (GI),<sup>9</sup> therefore, in other parts of India, traditional designs are copied or replaced with inferior products<sup>10</sup> (Thakur, 2010). The traditional process of designing and manufacturing such fabrics is complex and time-consuming, yet low-paying (Singha, Singha, 2020). The lack of advanced technologies negatively affects the competitiveness of textile clusters, which are declining.

### *Indian Institute of Technology Guwahati (IIT Guwahati)*

The Indian Institute of Technology Guwahati (founded in 1994) is the only IIT in the NER. It includes 11 faculties, five schools, and seven interdisciplinary centers

covering the main engineering, sciences, humanities, and management disciplines. IIT Guwahati consults and advises the public and state governments on industry, economy, and social growth with a focus on the NER.

In 2005, at the initiative of the Principal Scientific Adviser<sup>11</sup> (PSA) to the Government of India, the Rural Technology Action Group-North East (RuTAG-NE) was established, providing essential scientific and technological support for regional development (Bhattacharjya et al., 2019). In contrast to the conventional top-down approach, RuTAG-NE has embraced a bottom-up and integrated approach to technology development. This approach allows for the involvement of various stakeholders (academia, government agencies, non-governmental organizations (NGOs), regional experts, and micro-enterprises). Attempts are being made to upgrade existing technology to the needs of various clusters, but the process is complicated by the initially low level of technological competencies, implementation concerns, and affordability.

## Methodology

Case analysis is a qualitative research method that allows for a deeper understanding of a particular social phenomenon, event, or scenario (Yin, 2018). It is used when there is little information about the subject of research or the theory is not sufficiently developed. On its basis, new theories, hypotheses, and concepts are proposed. For our case study, we analyzed secondary data from scientific reports, books, policy documents, and studies. Semi-structured interviews were then conducted, with participants selected using purposive and snowball sampling methods. From April 2021-November 2022 respondents were interviewed, online and by telephone (Table 1). The interviews lasted between 30 and 90 minutes and were conducted in Hindi and English. The questions were structured on the following topics: functions of RuTAG-NE IIT Guwahati, interaction with regional actors and businesses, specifics of textile enterprises, technology transfer, and problems. To ensure the reliability of the data, data source triangulation methods that involve collecting data from different kinds of individuals were employed (Carter et al., 2014). The resulting information was inductively coded using MAXQDA software, allowing one to uncover important connections between the data, emerging themes, and existing literature. The data were assigned codes of different orders. The first-order codes represented informant-centric phrases. The second-order themes were more abstract in nature, reflected researcher-centric concepts, themes, and di-

<sup>7</sup> <https://www.fibre2fashion.com/industry-article/9435/innovations-in-the-world-of-textiles>

<sup>8</sup> <https://www.linkedin.com/pulse/technology-innovation-textile-sector-eastman-exports/>

<sup>9</sup> <https://assamtribune.com/low-awareness-in-state-on-gi-protection>

<sup>10</sup> <https://www.sentinelassam.com/topheadlines/sualkuchi-silk-under-threat-from-evil-twin-industry-wants-gi-to-be-safe-533474>

<sup>11</sup> The Principal Scientific Adviser, often known as the PSA, serves as a chief advisor to the government of India on issues that are associated with scientific policy

mensions, and finally one arrives at aggregate codes (see Figure 1). At the start, first-order codes were used. They assessed participants' observations regarding the role of IIT Guwahati in RIS (left side of Figure 1) and RuTAG-NE's activities in co-developing technologies for micro-entrepreneurs involved in small businesses. (right side of Figure 1).

Participation in the RIS performs four functions: building regional networks, upgrading regional clusters, enabling academic staff in regional participation, and entrepreneurial and human capital development. Three main RuTAG-NE activities have been identified: analyzing technology needs; developing user-centric technology, and disseminating open-source technology. At the third stage is the formulation of aggregate code: university engagement mechanisms and contributions to the RIS.

## Activities of RuTAG-NE

### Analyzing Technology Needs

For the successful implementation of technologies, it is necessary to understand the needs of micro-entrepreneurs involved in small businesses, for which two or three regional seminars are organized annually with their participation and the presence of NGO representatives. The first step in the needs analysis was to assess the actual demand for a particular technology. Information collected by RuTAG-NE is reviewed at committee meetings that determine priorities for scientific and technological support. The identified problems are discussed from different points of view by IIT faculty, regional experts, and NGO representatives. Some committee members communicate with micro-entrepreneurs. Priorities are determined depending on the significance of the region, its resource base, the scale of the problems, the capabilities of IIT Guwahati, and the expected economic impact on the business. If necessary, resources are attracted from the national level. From the findings, it is proposed that the need identification process adopted by the intermediary organization enables universities to engage with different regional stakeholders, including local communities working in informal sectors.

### Developing User-Centric Technologies

The selected problem statement is shared with IIT faculty members with the appropriate competencies. Additional studies are being carried out to evaluate development possibilities. Depending on the identified needs, existing technology is either adapted and modified (the preferred option) or a new one is developed. Under the guidance of IIT faculty, RuTAG-NE officials develop a prototype. According to one of the RuTAG-NE officials, it is an iterative process and getting adequate feedback is necessary. Due to limited resources and poor infrastructure, the technology developed is simple in design and easy for the local community to adapt. Field testing of prototypes is carried out jointly

**Table 1. Interview distributions**

Respondents	Number
RuTAG officials	3
Professors	4
NGOs	5
Local enterprise/fabricator	3
Regional experts	3
Government	4
Total	22
<i>Source: authors.</i>	

with end users (micro-entrepreneurs), whose feedback is taken into account during further development. If their requests are satisfied, the technology is considered ready for implementation. It is therefore proposed that a user-centric approach to product development by the intermediary organization facilitates the inclusion of local communities in the process of technology development, thereby enhancing technology adoption.

### Disseminating Open-Source Technology

At this stage, local enterprises or fabricators are identified for collaboration. RuTAG-NE does not receive any royalties or profits and does not patent its technologies; the developed products are available to everyone. If necessary, training is provided to produce similar products locally. Technology implementation in regional clusters is usually done by NGOs through government agencies' funding or corporate social responsibility (CSR) funds. Considerable attention is paid to collaborating with banks and other related organizations to resolve financial issues. Thus, we proposed that developing a simple and open-source technology enables the intermediary organization to effectively transfer technology to local enterprises or fabricators and NGOs, who can then disseminate it in regional clusters.

A summary of respondents' opinions on each of the considered aspects is presented in Table 2.

## Participation of IIT Guwahati in RIS

### Building a Regional Network

RuTAG-NE managed to create a system for regular interaction with regional actors, providing direct communication between users and innovation developers. It serves as a collaborative platform to keep all stakeholders confident and alleviate issues emerging due to variations in culture, social norms, and work ethics and acts as a change agent to overcome resistance to innovation. However, the distribution of NGOs across the region capable of implementing S&T intervention remains uneven. From our findings, it is therefore proposed that:

In the periphery regions of developing economies, the presence of an intermediary organization enables the technical university to establish a regional network.

### Upgrading the Regional Cluster

In the framework of the special ministerial program STINER, RuTAG-NE IIT Guwahati has developed several semi-automatic machines to raise the productivity of local textile clusters. The dissemination of technologies is carried out in individual families as well as by establishing common facility centers. Government co-financing plays an important role in the wider penetration of technologies, since the financial capabilities of RuTAG-NE, as a university intermediary, are limited. Most successful projects have been implemented jointly with the central government, while cooperation with regional or local government is not very active. It is therefore proposed that in developing economies, technical universities in peripheral regions are more likely to upgrade traditional industries by offering improved and easy-to-adopt mechanized technologies.

### Human Capital Development

RuTAG-NE is interested in training and developing local enterprises or fabricators. RuTAG-NE technologies can be produced where demand arises if local enterprises are trained in that location. Some fabricators find themselves interested in collaborating and taking the products forward to disseminate in regional textile clusters. Further, to incorporate teaching and research and provide consulting services regarding various issues faced by the rural sector, the School of Agro and Rural Technology has been established. From the findings, it is proposed that in the periphery regions of developing economies, the presence of intermediary organizations not only enables technical universities to engage in knowledge and technology transfer but also enables the university to identify future academic units to support the local economy.

To involve academic staff in supporting regional development, RuTAG-NE informs faculties and students about the problems faced by the local community and encourages them to participate in the exchange of knowledge and the search for possible solutions. The faculty involved in RuTAG-NE activities is voluntary and they often spend their valuable time on field visits interacting with micro-entrepreneurs involved in small businesses. RuTAG-NE receives certain financial support from the Principal Scientific Advisor (PSA) (central government institution) to conduct its activities. It is therefore proposed that in the periphery regions of developing economies, the presence of university intermediary organizations enables academic staff to become aware of regional issues and encourages them to participate in regional engagement.

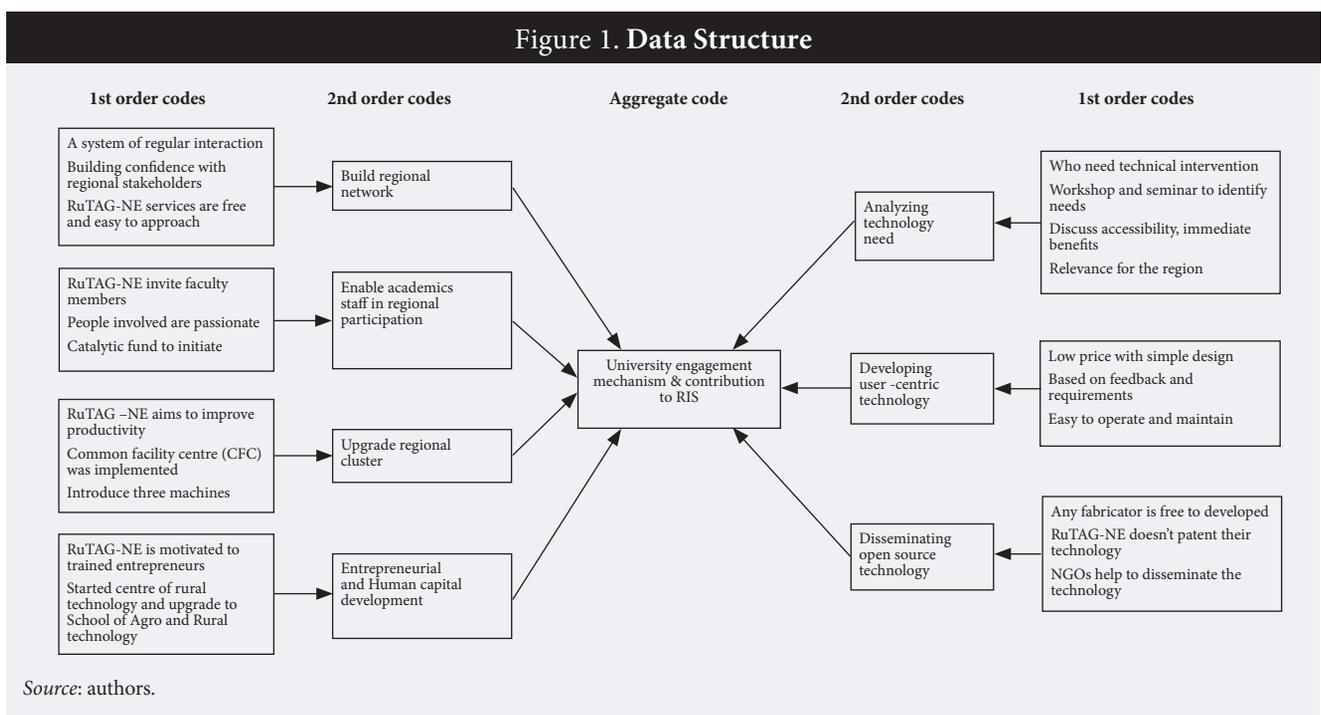
Table 3 shows excerpts from interviews with respondents on each of the indicated aspects of IIT Guwahati’s participation in the RIS.

### Discussion

The results of the study show that a technical university can play a key role in the socioeconomic development of peripheral regions in developing countries such as India. As part of the IIT Guwahati ecosystem, RuTAG-NE promotes the co-creation of technology and knowledge co-production and dissemination among regional actors.

This process allows for the involvement of the most diverse segments of the population and shares their needs and feedback to overcome challenges in upgrading the technology in the regional cluster and increase production. Figure 2 presents an interactive model of IIT Guwahati’s participation in the regional innovation system.

Figure 1. Data Structure



**Table 2. Excerpts from interviews with respondents regarding RuTAG-NE activities**

Dimensions	Citations from interview
Analyzing technology needs	What I'm saying is technology need analysis first things is that, what's the basic need of this particular technology... (Regional Expert # 1)
Developing user-centric technology	It is a learning process and the field trial is very important to get right feedback... (RuTAG-NE # 2)
Disseminating open-source technology	RuTAG-NE does not earn any loyalty or profit and neither patented these technologies... (Professor IIT Guwahati # 1)

*Source: authors.*

Such a regional network, working on a “bottom-up” principle, makes it possible to quickly identify the technological demand of micro-entrepreneurs, strengthen the trust of stakeholders, and stimulate openness to innovation. University staff accompanies the entire process of development and technology transfer. By going beyond the conventional methods of technology transfer and commercialization, technical universities can enhance the potential of local enterprises or fabricators by sharing open-source technology, which in turn commercializes and diffuses the technology in regional clusters, such as the textile sector, to improve the productivity of microentrepreneurs working in this sector. In other words, universities are establishing a new balance between the commercial and non-commercial components of their activities in order to increase regional economic potential.

**Policy Implications**

In developing economies, technical universities can play a key role in the RIS of a periphery region, subject to appropriate national policies to support regional development (Gunasekara, 2006a). In addition, much depends on the type of university, on the willingness of its academic staff to voluntarily participate in the exchange of knowledge and experience with local entrepreneurs and other stakeholders (Gunasekara, 2006b; Salomaa, Charles, 2021). The availability of high-quality departments as a precondition for regional development is not mandatory. In developing countries, simple and less sophisticated technologies can serve as viable solutions to address the challenges of traditional industries (Theodorakopoulos et al., 2014).

The case of the north-eastern region of India represents a working regional ecosystem, where IIT Guwahati plays a central role, performing its functions through a proxy organization RuTAG-NE with the support of the PSA (central government agency). RuTAG-NE technologies are not subject to patenting and, as a result, easily transferable where demand arises. However, the conceptual framework of the RIS derived from our case study has its limitations when transferred to other contexts. RuTAG-NE is attached to academic institu-

tions with a limited budget. At the same time, financial support is mainly from the central government, and the degree of involvement of regional and local authorities remains insufficient. In turn, the limited purchasing power of micro-entrepreneurs involved in traditional industries such as textile sectors further constrains the potential for the wider dissemination of technologies.

**Conclusion and Further Research**

This study expands our understanding of how technical universities can contribute to meeting societal needs and participating in RIS activities, especially in peripheral regions. The important role of the intermediary organization is emphasized, which organizes social learning and joint development of demand-driven technologies, expanding the range of segments of the population involved in the innovation system.

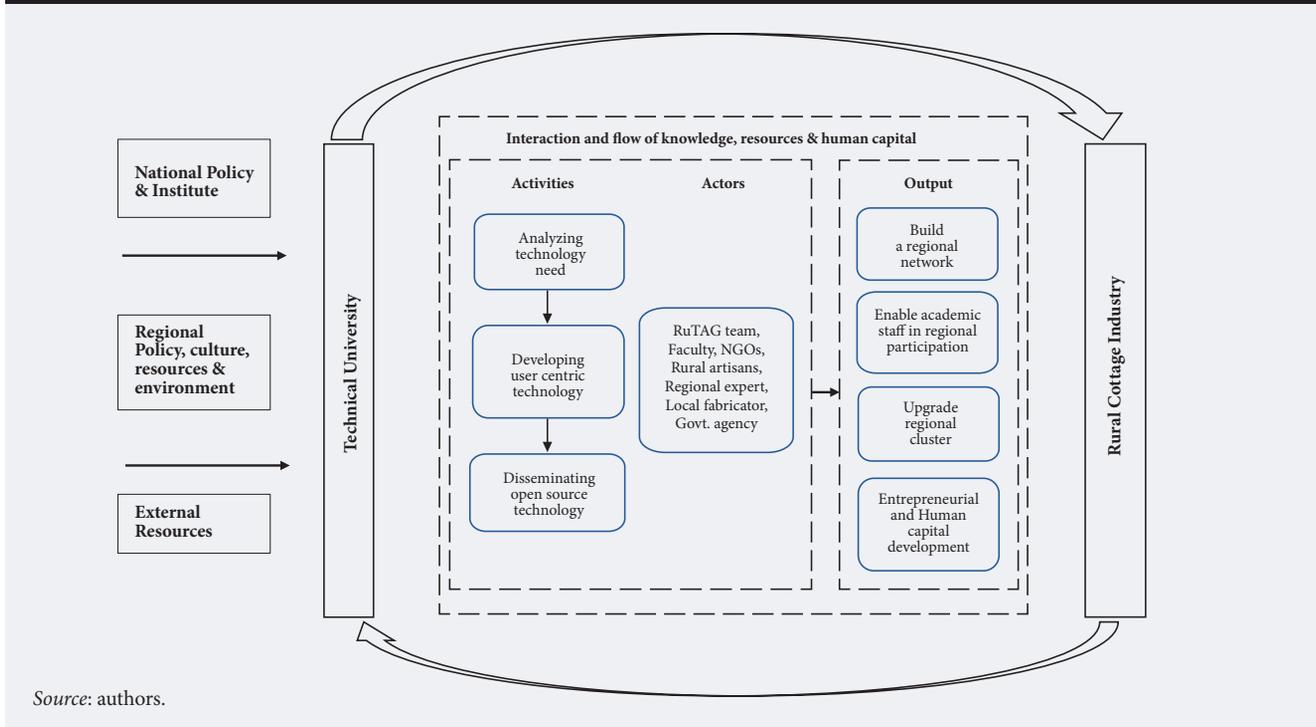
In terms of the transferability of the findings to other contexts, it is important to note that the main goal of case analysis is to provide a comprehensive illustration of the specific case under investigation (Stake, 1982). However, the information and conclusions obtained from such an analysis can be considered a working hypothesis for further research. The transferability of results depends on the degree of compatibility of the “sending” and “receiving” contexts (Mariotto et al., 2014).

A comparative analysis of the activities of other RuTAG centers (seven in total across India) will allow us to study their evolution, the effects of their activities, and the composition of regional stakeholders. The possibilities of using or replicating the presented interactive model in other technical universities or engineering colleges (besides IITs) in India and other developing countries can be explored. Moreover, in the case we examined, most of the university staff involved in RuTAG-NE activities are voluntary. Further research would benefit from exploring why and how academicians and scientists are involved in supporting regional development, what motivates them, and what policy initiatives and incentives might enhance such involvement.

**Table 3. Excerpts from interviews with respondents on the role of IIT Guwahati in the regional innovation system**

<b>Building regional network</b>
<p>It is a good system of regular interaction with regional actors including, NGOs, villagers, and RuTAG-NE IIT Guwahati, as it helps to directly connect end users and innovators. (Regional Expert # 1)</p> <p>I say ‘we’ in RuTAG-NE because other stakeholders play a very important role even though IIT Guwahati is leading this centre. For example, when we started working on handloom and weaving issues, we had very limited knowledge of this sector. We learn and collaborate with other stakeholders and experts, such as the central silk board, to develop S&amp;T intervention in this sector. Another thing we learn is that it is important to take other stakeholders into confidence to work together. In NER, there were hardly any NGOs who are involved in S&amp;T implementations. At some point, we have to guide and train them. We build confidence with the NGOs and the NGOs use to build the confidence of the artisans or the villagers. (Professor IIT Guwahati# 1)</p>
<b>Upgrading regional cluster</b>
<p>A common facility weaving centre has been implemented in weaving cluster in Baksa district (Bodoland), Assam. The land was donated by six villagers to set up the centre; technology support was provided by RuTAG-NE IIT Guwahati. Weekly, around 120 women from six villages use the facility, and around 20 women use it on a daily basis in a routine manner. This not only provides weavers to increase their productivity but also allowed them to promote their traditional Bodo tribe textiles. The common facility is maintained by the community group (villagers) and later formed a cooperative society to commercialize the products and increase marketing and sales activities. The project was funded through central government Scheme of Fund for Regeneration of Traditional Industries (SFRUTI) project for rural cluster development and was completed in 2018. (NGO # 1)</p> <p>Sixty hank to bobbins machines were disseminated in weaving clusters in Nagaland. Around 200–300 people from nearby villages work in the cluster. Weaving technology was disseminated in the common facility centre as well as in individual families. Eri cocoon openers were also disseminated in Mizoram. We can disseminate our technology in the different north east region through the STINER project. (RuTAG-NE # 1)</p>
<b>Entrepreneurial &amp; human capital development</b>
<p>I used to work as a steel fabricator, and later I developed an interest in textile machine manufacturing. I was contacted by RuTAG-NE IIT Guwahati in 2013 and gave a project to develop two machines, i.e. pirn winding machine and hank to bobbin machine. Since then, I have been working with IIT Guwahati. I started with an electrical background and got the inputs in manufacturing and mechanical engineering while working with RuTAG-NE. I got publicity through collaboration, and now my company is a government-approved supplier for textile machines. Knowledge transfer usually takes place informally. Since 2016 these machines have been delivered in different states in NER, including Sikkim, Nagaland, Assam, Mizoram, Arunachal Pradesh, and Tripura. (Local enterprise # 1)</p>
<b>Enabling academic staff in regional participation</b>
<p>My involvement in RuTAG-NE projects is mainly because of my passion to work for rural people, but I must say that getting involved in rural activities is not easy. It takes time to interact with them to understand their needs. It's not something you just design and build in the lab and give to them; many a time, rural technology fails when you don't understand their need and how they work. (Professor IIT Guwahati #2)</p>
<p>Source: authors.</p>

**Figure 2. RuTAG-NE IIT Guwahati’s interactive model to co-create demand-driven technology and contribute to RIS**



Source: authors.

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