

# The Role and Significance of Academic Institutions for Managing Technology Development and Diffusion at the Rural Level

Jayshree Patnaik and Bhaskar Bhowmick

**Abstract**—The ability to design, develop and disseminate technologies has become a critical organizational acumen as firms, institutions strive to manage with a rapidly changing global scenario. However, the context and the imperative of designing and developing technologies vary when it comes to managing at the rural level. Many organizations have realized the importance of developing affordable technologies to meet changing demands at the rural level. Given the nature of academia, there is scarce research and discussion on the technology management practices for the rural economy. This study employs the Rogers' Diffusion of Innovation Theory to study the technology development-dissemination from an academic institution perspective using a case-based method. The study is based on the primary mode of data. The findings of the study provide an insight into the exigent need of reorganizing technology management and practices for addressing the demands and needs of the rural economy.

**Index Terms**—Design, development, diffusion, innovation, technology management.

## I. INTRODUCTION

The significance of technology and innovation management is increasing both in business and academic practice. Particularly in the technology management field, we are appraised of a few academia who carry out research devoted to developing new product and service for the people who are poor and marginalized. Currently, there is no comprehensive analysis of the technology management practices undertaken by academic institutions or universities working for the improvement of lives for people who are downtrodden and not economically well-off at the regional level [1]. There also exists a lacuna in understanding the approach undertaken by the academic institutions on how they maintain knowledge symmetry and equitable technology development and transfer among communities [2].

The objective of the study is to explore the technology management practices from an academic institution perspective using a case-based method from the Indian subcontinent. The Indian subcontinent provides an ideal arena to undertake our study on technology management practices concerning academic institutions. India hosts a large number of higher education institutions and multinational companies where many of them are engaged in

various development initiative. Nearly 72% of the Indian population resides in rural areas. The ever increasing demand for technological needs can be witnessed in the Indian rural context among various sectors. Given such a scenario, the entire dynamics of management of innovation and dissemination of technology suffices the need for exploring the role for academic institutions in such practice.

The study is based on RuTAG (Rural Technology Action Group) which is a prominent initiative by the Office of the Principal Scientific Advisor (PSA) to the Government of India. RuTAG was established in the year 2003-04 to develop affordable, appropriate technologies with a higher degree of science and technology intervention towards the demand-driven problems for the rural areas of India. RuTAG is operational in seven higher academic institutions from India known as Indian Institute of Technology (IIT) which are situated at different states of the country. Currently, there are 52 technologies from the seven RuTAG centres which are successfully developed and demonstrated in the field to address the unmet needs of the rural areas. Therefore, it is a necessity to explore and recognize the functionality behind effective technology management practice. With a focus on technology management at the rural level, this paper has two objectives. First, it aims to contribute to the literature on the effective management of technology development and diffusion through a conceptual framework based on academic institutions. Second, it contributes to the current body of technology management practices by identifying the opportunities, enablers, challenges.

The rest of the study is structured into the following sections: Section two presents the theoretical evidence and a framework for the concept of technology development and diffusion. Section three presents the methodology adopted for the study. Section four presents the findings. Section five presents the discussion followed by the conclusion of the study.

## II. LITERATURE REVIEW

In the globalized age where information process, intelligent systems, high-end manufacturing systems with improved supply system and decision models are modernizing the mode of development, there exists challenges and problems at the rural level where the practice of improved technology management is lagging. Often cutting-edge technologies developed in firms fail to reach the rural masses and the innovation simply gets discarded as they are not apt to the needs of the community. In such situations, there is a need to design technology for rural level through

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effective management and practices. The discourse on technology management is lately augmented with the engagement of academic institutions in the regional development being an anchor in boosting the rural economy [3]. Lately, academic institutions have transitioned from a passive creation of knowledge to a more driven and engaged function towards creating a development that is creating a huge impact on the lives of people for regional growth [4]. It is increasingly becoming important for research labs and academic institutions to be a driver and enabler of affordable and sustainable technologies for users in a constraint environment [5].

It has been earlier posited that academic institutions have a social responsibility to provide directions to faculty, students and often their decisions have an impact on social, economic, environmental aspects on the communities around them [6], [7]. Academic Institutions and Universities have been recognized as a prime contributor for promoting sustainability at a regional level [8]. Therefore, it is pertinent to understand how such mechanism happens and managed by institutions to facilitate local development. We will use the theory of Diffusion of Innovation to discern the dynamics of technology development, adoption and diffusion in the academic institutions.

The Diffusion of Innovation Theory has extensively been employed to investigate technology adoption across various sectors. The study on diffusion includes technological innovation. The process of adoption is defined as the decision to fully utilize the innovation in its best form available [9]. While Diffusion is described as the process where the innovation is disseminated or communicated by the help of specific channels over time through members of a social system. A five-stage innovation-diffusion process generally involves (i) knowledge (ii) persuasion (iii) decision (iv) implementation (v) confirmation [10]. The five stages are intrinsically interrelated in an ordered manner. Innovation begins with the knowledge creation where an organization or individual explores the situation and seeks knowledge to address it. This stage involves answers such as 'what', 'how', 'why' to study about the background and existence of the problem, its innovativeness and implications. The persuasion stage mainly concerns with the characteristics in which innovation may be perceived among the users. It includes attributes such as relative advantage, compatibility, complexity, trialability and observability which determines the level of adoption and acceptance among the users. The decision stage confirms whether the design involved in the technology is made according to the requirements [11]. The next stage is the Implementation where innovation is taken to the field and administered for utilization. The final stage is the confirmation stage which confirms whether the innovation is accepted or rejected. If the users do not find the innovation or appropriate or suitable, then they reject the innovation. Therefore, the following stages are needed to be considered while developing the technology. Fig. 1. represents the five stages of an Innovation-Diffusion Process.

Through this framework, we will analyze the technology management practice that the academic institutions undertake for effective development and dissemination.

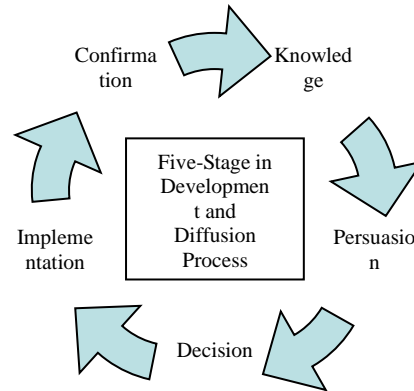


Fig. 1. Stages of an innovation-diffusion process.

### III. METHODOLOGY

The prime aim of the study is to investigate and discern the phenomenon of technology management practices from an academic perspective. We followed a qualitative method for the study and adopted a case-based method. A single case was adopted for the study as it enables to intensify the depth of observations. We searched over the web to identify academic institutions from India engaged in developing the rural economy through technological intervention. We discovered the unique mission of Rural Technology Action Group (RuTAG) which is an initiative by the Government of India to improve the lives of rural people through effective management of technology [12]. We did a primary case survey on RuTAG and visited two of their centres in the northern and eastern part of India. The two RuTAG centres are RuTAG IIT Delhi and RuTAG NE, IIT Guwahati. We visited the centres in June and July 2019 respectively. The selection of the two centres for the case study was backed by a purposive sampling method. We engaged in discussion with the working members, field technical staff and faculties of RuTAG to discern and observe how rural technological problems, challenges are addressed and solved. One of the intriguing learning was the difference in the approach of technology management at an organizational and academic level.

The central aim of RuTAG is to improve the rural economy by increasing productivity of life and livelihood. This is generally achieved by making a technological intervention, either by increasing efficiency, improved ways of dissemination, reduction of drudgery through modified design and synergizing with various non-voluntary and government agencies. The technology development and intervention by RuTAG are in the area of Agriculture, Handicrafts, Textile, Energy, Environment, Animal Power, Water, Health & Sanitation. RuTAG primary mission is to recognize technology needs of a particular region; identify issues in existing technologies; upgrading, modification of existing technologies to improve adoption and diffusion at the grassroots; identifying relevant institution which can address problems and design solutions that cater to the local condition; raising awareness of problems occurring at the grassroots among students and faculties in the institute to create novel solutions. The next sections describe the functioning of RuTAG with its entire dynamics of

development and diffusion.

#### IV. FINDINGS

Developing and designing technologies that are inclusive and appropriate in the approach needs strategies that enable communities to rise out of poverty. RuTAG taps into the transformational practice by mobilizing the exchange of knowledge between various academic institutes, technology developers and users with their unique framework. RuTAG emphasizes the significance of coordination among various stakeholders to assess the technology demands and minimize knowledge asymmetry.

There is total of seven RuTAG established at IITs. Each RuTAG at a specific IIT has been made the nodal head of a particular zone being entrusted the responsibility of addressing and solving problems which are related to that particular region. Furthermore, each RuTAG has an extensive network with various local partners and Non-Governmental Organizations (NGOs). These NGOs and local agencies are directly linked and closely work with communities. RuTAG conducts a workshop/meeting twice a year with the help of these organizations where people from rural communities bring their problems through which RuTAG is made aware of technological problems that exist at the grassroots. It is to be mentioned that all the problems are demand-driven. RuTAG assesses the problems and identifies relevant institutions or intervene with its existing expertise to solve challenges. The technological intervention and development involve various design iteration to ensure compatibility and appropriateness. RuTAG further demonstrates these design in the workshop through the help of its local players to get feedback in the design. If the design is not compatible with the users, then the design gets modified until it is accepted by the users and implemented in the field.

We studied the functionality of various technologies developed under the aegis of RuTAG from websites, reports, and our direct observation and interaction with the members and staff of the respective RuTAG centre. We tried to decipher how these technologies were developed, modified and given back to the users. Furthermore, we tried to understand how the plausible challenges were addressed and how indigenously they have been developed. Few technologies from RuTAG have achieved remarkable success among the users as they have improved the livelihood of rural communities. Fig. 2, Fig. 3, Fig. 4 represents few technologies which has been successfully developed and disseminated by RuTAG. Fig. 2. represents an Eri Cocoon Opener developed by RuTAG NE, IIT Guwahati. Fig. 3. represents a Treadle Pump developed by RuTAG, IIT Delhi. Fig. 4. represents a compressed feed block machine by RuTAG NE, IIT Guwahati. Some salient features of these modified technologies include cost-effectiveness, low-cost, lightweight, easy construction portable, easy assembling and maintenance, high operation stability, energy-efficient, drudgery reduction. The impacts from these give rise to new market opportunity, increase revenue, better working environment, new livelihood options. The figure shown

below represents the technologies developed by various RuTAG.



Fig. 2. An Eri Cocoon opener by RuTAG NE, IIT Guwahati.



Fig. 3. A Treadle pump by RuTAG, IIT Delhi.



Fig. 4. A Compressed feed block machine by RuTAG NE, IIT Guwahati.

#### V. DISCUSSIONS

Currently, when there is a need of socio-technical change; technology management needs to be rooted in social and organizational innovation. One of the eternal challenges persisting at the rural level has been 'poverty', which according to [13] may be attributed to three primary reasons: a paucity of income and resources, a dearth of approach to basic services, and socio-cultural exclusion. A major step in undertaking innovation and tackling poverty and inequalities between nations is an effective design methodology. Eradicating poverty or meeting the needs of people in low-resource settings requires designing, developing and implementing appropriate technological innovations, which would result in products and services to support development [14]. The prime idea of design is to alter an existing problem into a desirable solution, which will have a significant contribution in meeting the needs of un-served people dwelling in a resource-constraint environment [15].

A nine design principle aimed at guiding the designers has been devised which have the potential to improve the design mechanism specifically in developing countries [16]. The principles include: empathy-building through a co-design approach; testing of final product in-context location; understanding the risk of importing technology without adapting it to local needs; undertaking correct distribution strategies to diffuse products in the markets; exploiting the rural and urban benefits; understanding the impacts of poverty alleviation on women and children; identifying the appropriate technique in project management; perks of working in interdisciplinary teams; and finally, support from the government along with local players. Various criteria for designing and disseminating of technology in a developing country has been represented in terms of affinity, desirability, reparability, durability, functionality, affordability, usability

and sustainability [17]. Technology development, adaptation and sustenance in remote, resource constraint areas are highly dependent on its appropriateness [18]. We will discuss what are the different factors affects the technology and knowledge management practices for RuTAG. From the findings, we observed that technology development and management are influenced by three factors such as (i) Social (ii) Economic (iii) Organizational. Therefore, it is of prime importance to understand various social, economic, organizational factors that influence the design, development, diffusion and scaling-up technologies from these kinds of institutions. The table shown below represents how each factor influences the development process.

TABLE I: SOCIAL FACTORS INFLUENCING TECHNOLOGY MANAGEMENT

<b>Social Factors influencing technology management</b>	Technology Transfer through Open replication facilitates easy adoption
	Human-centric design and ergonomically developed technology increases compatibility
	Continuous feedback mechanism between the developers and users facilitates reliability and improves technology adoption

Table I represents the social factors that influence the technology management. RuTAG practices an open-source of technology process where users can replicate the technology design and this improves reliability and large adoption. Also, RuTAG ensures all the technologies are ergonomically designed and human-centric in nature of that it increases compatibility and facilitates for easy usage of technology among the users. During the designing and development process, there is a continuous interaction among the developers and users to ensure that the design is appropriate according to the needs of the users. Therefore, the social aspects in technology development cannot be overlooked and it is an important criterion for effective management practice.

TABLE II: ECONOMIC FACTORS INFLUENCING TECHNOLOGY MANAGEMENT

<b>Economic Factors influencing technology management</b>	Creation of Entrepreneurial Opportunity and new market because of up-gradation in the technology generates revenue for the rural areas
	Improved and modified performance entails capacity building which thereby creates empowerment

Table II represents the economic factors that influence the technology management. The technologies are designed in such a manner that they create a platform for entrepreneurial opportunity. With the presence of available technical expertise, the technologies are modified giving rise to improved productivity and efficiency. Therefore, it is pertinent to identify how an economic factor affects technology management.

Table III represents the organizational factors that influence the technology management. Organizational factors are an important aspect of managing technology. The RuTAG has maintained a large network with institutes and local agencies and organizations who aid in the development

process. The local agencies play a significant role in providing training and demonstration of technologies to the users which increases technology adoption. Also, financial assistance from the Government, helps in arranging funds for developing the technology.

TABLE III: ORGANIZATIONAL FACTORS INFLUENCING TECHNOLOGY MANAGEMENT

<b>Organizational Factors influencing technology management</b>	Extensive networking with other academic institutions, various research and development institutions helps to mitigate problems at the grassroots as technical expertise aids in better local design
	Financial assistance from the Central Government aids in the development
	Active collaboration with voluntary agencies, non-governmental organizations increase technology adoption and acceptability among end-users by bridging the gap
	Demonstration and training of improved and modified technology by the partners' agencies increases the adoption and reliability among end-users

An Initiative from the academic institutions like RuTAG for boosting the rural economy is enhancing their development in local activity by upgrading their work on sustainable development and investing in collaborating relationship for local interest, working exhaustively to make their presence felt. Therefore, exhaustive studies are required to appraise the contribution made by such academic institutions.

## VI. CONCLUSION

The study contributes to the state of the art by identifying the engagement of academic institutions working for development at a local level. This study sheds light on the various aspects of academic institutions engagement for rural transformation. The contributions of this study highlight three facets in which the academia plays a significant role in stimulating rural transformation through effective technology management practices: promoting appropriate technology development, supporting capacity development and entrepreneurial orientation among communities, and the provision of coupling government assistance with increased participation of active stakeholders in knowledge management and implementation of technological projects to ensure a transformation.

The contributions also emphasize the pivotal roles played by the non-governmental organizations, civil societies to support the technical management for bridging the knowledge gap, raising awareness of technology alternatives, facilitating technology transfer, mobilizing local capacity building for reducing the gap between technology developers and end-users. The study, therefore, devoted to investigating different factors of innovation and technology management concerning rural development to broaden our horizon of how such a process and mechanism contributes to foster the social and economic transformation of rural communities. The significance of academic coordination and active engagement in transition endeavour for technology change can be illustrated by academic institutions approach to the

successful revamp of its social and economic structure for the rural areas. Scaling- up and diffusion are of important aspects for making a technology management practice. The adoption and dissemination of technologies, while bearing the potential to answer economic and social challenges, brings new opportunities.

#### CONFLICT OF INTEREST

The authors declare no conflict of interest.

#### AUTHOR CONTRIBUTIONS

Jayshree Patnaik conducted the research; analyzed the data and wrote the paper. Bhaskar Bhowmick proofread the paper and outlined the structure for the paper. All authors had approved the final version.

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