

Appropriate Technology: Revisiting the Movement in Developing Countries for Sustainability

Jayshree Patnaik, Bhaskar Bhowmick

Abstract—The economic growth of any nation is steered and dependent on innovation in technology. It can be preferably argued that technology has enhanced the quality of life. Technology is linked both with an economic and a social structure. But there are some parts of the world or communities which are yet to reap the benefits of technological innovation. Business and organizations are now well equipped with cutting-edge innovations that improve the firm performance and provide them with a competitive edge, but rarely does it have a positive impact on any community which is weak and marginalized. In recent times, it is observed that communities are actively handling social or ecological issues with the help of indigenous technologies. Thus, "Appropriate Technology" comes into the discussion, which is quite prevalent in the rural third world. Appropriate technology grew as a movement in the mid-1970s during the energy crisis, but it lost its stance in the following years when people started to describe it as an inferior technology or dead technology. Basically, there is no such technology which is inferior or sophisticated for a particular region. The relevance of appropriate technology lies in penetrating technology into a larger and weaker section of community where the "Bottom of the pyramid" can pay for technology if they find the price is affordable. This is a theoretical paper which primarily revolves around how appropriate technology has faded and again evolved in both developed and developing countries. The paper will try to focus on the various concepts, history and challenges faced by the appropriate technology over the years. Appropriate technology follows a documented approach but lags in overall design and diffusion. Diffusion of technology into the poorer sections of community remains unanswered until the present time. Appropriate technology is multi-disciplinary in nature; therefore, this openness allows having a varied working model for different problems. Appropriate technology is a friendly technology that seeks to improve the lives of people in a constraint environment by providing an affordable and sustainable solution. Appropriate technology needs to be defined in the era of modern technological advancement for sustainability.

Keywords—Appropriate technology, community, developing country, sustainability.

I. INTRODUCTION

TECHNOLOGY is intrinsically linked with an economic and a social structure. There is no such technology designed specifically for a developed or developing country. Innovation in technology is the answer for rapid development and globalization in the present times. This plays a major role in satisfying the demand and needs being expressed by the people.

Developing countries have communities or regions where the rate of development of technology is not proportionate.

Jayshree Patnaik and Bhaskar Bhowmick are with Indian Institute of Technology Kharagpur, India (e-mail: shreepatnaik@gmail.com, bhowmickb@gmail.com).

There is a saying "Think globally, act locally". Therefore, while identifying a problem it is necessary to link possible solutions for multiple issues. Rural locations in developing or underdeveloped countries have less access to resources, for which, before designing any technology for them, it is not only important to ask what they need, but also to discern their hidden wants. People's demand for technology can be easily recognized when we can focus on what they actually do in their daily routine. Appropriate technology is developed to be "appropriate" to the context of its use. Appropriate technology can be better understood as the simplest level of technology which can effectively achieve an intended purpose in a specific location. The motive of appropriate technology is to create a self-reliant and eco-friendly system where people in an under-developed region can effectively manage their local needs. The true challenge lies in empowering people from marginalized sectors where they can effectively exercise their lives.

The rest of this paper is organized as follows: Section II explains about the observations in the existing literature. The observation section discusses the history, definitions and challenges faced by appropriate technology. Section III presents the literature review. Section IV attempts to discuss appropriate technology and grassroots innovation. In the final section, we present our future research scope.

A. Methodology

A systematic review of literature is done in this study. The theme for this search is "Appropriate Technology and its Applications". The search was basically done in four search engines: SCOPUS, JSTOR, EBSCO and Google Scholar. The literature retrieved primarily shows how appropriate technology has evolved over years. The literature shows that earlier appropriate technology was only used in the context of developing countries. But in present times, studies on appropriate technology have gained momentum; it is widely implemented in both developing and developed countries as a label of bringing change to the lives of people. Over all these years, appropriate technology has evolved to embody a large literature including designing, manufacturing, and implementation of simple technologies. The areas which received much focus in the literature are community, innovation, technology transfer, sustainability, grassroots innovation, third world countries, bottom-of-pyramid, and alternative technology.

II. OBSERVATION IN EXISTING LITERATURE

A. History of *Appropriate Technology*

Appropriate technology started as a major movement in India in 1930, when its leader, Mohan Das Karamchand Gandhi, propagated the idea of setting up industries in rural places. He stressed that the future lies in those regions where maximum numbers of Indians reside, which is rural areas. The spinning wheel was his ideal machine of appropriate technology, which he anticipated as an instrument for development that would bring self-sufficiency to people [2].

During the 1970-1980s Appropriate technology became a major grassroots movement, which tried to re-explore technology as a tool for development. In South America, Appropriate technology rose up in an atmosphere between social disturbance and political oppression. The movement led to building up civic network and technology, and to analyze appropriate technological ideas in a convenient way so as to cater to the needs of a region [25].

Appropriate Technology was universalized by Schumacher in his book "Small Is Beautiful: Economics as if People Mattered" (1973), when he introduced the concept of Intermediate Technology. Schumacher [20] put forward intermediate technology as a technology where the poor could help themselves by making a sustainable process on income generation. This intermediate technology would be an intermediary lying between the sophisticated technology of a developed country and the low-cost technology of a developing country. The term Appropriate Technology has been used as a substitute for intermediate technology, since the former includes the social and cultural dimensions of innovation [27].

B. Definition of *Appropriate Technology*

A small-scaled technology designed and developed by a community to satiate their needs is known as Appropriate Technology. Appropriate Technology involves the utilization of skills to fulfil the basic human needs of a community, where the use of high-tech technology is difficult. According to Willoughby [32], appropriate technology is a technology customized to benefit the socio-economic needs of a particular region at a particular time. It is a motif that tries to distinguish among various technologies according to their aptness for a distinct objective. Pattnaik and Dhal [18] posit that appropriate technology is a postulation of ideas and a structure in which we have to reflect and work for the development of a region. The motive is to build a platform for choosing a technology which leads to development. Appropriate technology is an empowering technology which needs to be sustained so that it can be used in the future [24]. Pellegrini [27] stated that technology can be termed as "appropriate" when its initiation in a region creates self-reinforcement, thereby supporting the growth of the locality and when the requirement and development can be solely decided by the community. Lissenden et al. [14] stated that appropriate technology is that friendly technology which seeks to improve the lives of people in a restrained environment.

Kerr [13] finds Appropriate Technology as the application of knowledge of science for development. It is a movement which explores and tries to harness the potential of both simple and sophisticated technology, so that it will lead to improvement and bring about sustainability. Akubue [2] posited that appropriate technology is not only tangible equipment, but also a methodology adopted to improve and develop the community by encompassing a wide body of knowledge and techniques. Appropriate technology is a symbol for development. Appropriate technology is also termed in various denotations such as "alternative", "intermediate", "self-reliant", "soft", and "progressive" technology [29].

C. Criticism of *Appropriate Technology*

Technology is often considered as good by judging its technical and economic values, but its potential in solving community problems and conserving the environment is often ignored [23]. Teitel [29] stated that a technology is cited to be inappropriate, if the basic needs of a market and ultimately the end users are not properly addressed, or if a technology is built with imported materials or requires an extravagant use of goods, and if it does not suit to the local market. Ahmed [1] found that appropriate technology loses its importance in less industrialized countries when the gap between developed and developing countries starts to increase. Appropriate technology is often termed as poor-man's technology or simple technology. Because of the perception that appropriate technology holds only good for poor or less developed countries, there is a need for an integrated framework. Willoughby [32] found that despite being a substantial movement, appropriate technology has prevailed as an inferior theory among policymakers. Appropriate Technology has not justified to what range the conventional interest can be held together for a societal cause.

III. LITERATURE REVIEW

Appropriate technology has been presented in different themes over the decades. In the literature, appropriate technology has mainly been discussed in terms of context, methodology, sustainable development, innovation, and as case studies. The themes and time periods in which appropriate technology has been discussed by various scholars over the years is discussed below.

A. *AT as Context (1978-2015)*

During the period 1978 to 2015, appropriate technology has been discussed in its context or conceptualization. Bowonder [6] discussed the issues where less industrialized countries encountered problems in choosing and adopting a new technology. Teitel [29] tried to seek reasons as to what led to the "inappropriateness" of a technology and highlighted the problems of appropriate technology in less industrialized countries. Bowonder [6] tried to identify the barriers that developing countries faced while selecting and forecasting a technology. The researcher tried to determine the criteria and the preferable path to follow in the selection of a technology.

Pellergrini [27] suggested a working definition of appropriate technology and proposed success criteria for its implementation. Ahmad [1] posited that developing countries lack expertise in determining the appropriateness of a technology with respect to quality, cost-factor and sophistication. The problem arises when developing countries introduce new technology for development, since the measures undertaken for evaluating before and after implementation are not fully defined. The researcher proposed a four-phase model for technical assessment. Akubue [2] posited that appropriate technology is not a fixed technology. Appropriate technology is designed to foster innovation. The researcher supposed that appropriate technology has evolved as a movement aiming to overcome problems faced in community development. Lissenden et al. [14] focused on the theories, beliefs and gaps that can be learnt from appropriate technology. Appropriate technology has grown to include different approaches for designing and implementing technological solutions.

B. AT in Sustainable Development (2011-2014)

Appropriate technology received attention in the literature of sustainable development post 2010. The literature has identified appropriate technology as a very useful tool for sustainable development [5]. Zelenika and Pearce [33] suggested that research on sustainable development through appropriate technology seldom reaches the community, so there should be a scope for collaborative design in the web where people can modify or give suggestions to an existing design. Amiolemen et al. [3] also stressed on the idea of promoting sustainable development through appropriate technology. The researcher also aimed on how the ideals of appropriate technology can be used for studying about soil. Appropriate technology can lead to sustainability when people needs are properly addressed. Sianipar et al. [22] focused on creating an integrated framework to evaluate the impacts of materials by aligning it with the tenets of appropriate technology.

C. AT and its Methodology (1996-2013)

In developing countries it is of prime importance to choose a technology which is appropriate in the social context. The bottom line is that the technology should not be short-lived and that the design should be such that it paves path for continuous development. The challenge faced by developing countries in managing their production capacity is discussed by Bruun and Mefford [9]. Wicklein [31] predicted and identified factors to determine the success or failure of recent technological applications which are required to solve problems in developing countries. Developing countries also encounter challenges while attaining new technology from developed countries via the technology transfer method. Tahmoonesnejad et al. [28] suggested factors for the localizing technology within firms, in order for a business to gain a competitive edge. Sianipar et al. [22] developed a methodology which incorporates the characteristics of appropriate technology and axioms of design approach.

Appropriate technology should be initiated from territorial conditions rather than from a given technical condition.

D. AT and Innovation (2010-2012)

Innovation in technology in the last few decades has revolutionised society's ability to solve problems. Appropriate technology identifies that social, environmental, cultural, and political concerns are as important like the technical requirements in the design of innovative products and services [14]. Appropriate technology is driven by innovators who develop technologies which are appropriate to a context. Buitenhuis et al. [10] explored how the open sharing of designs and technicalities can improve the efficiency and feasibility of appropriate technology. The major roadblock in achieving innovation is the lack of access and utilization of proper knowledge. However, with the rapid rise in information technology, there is much scope for knowledge building, community interaction and collaborating with various platforms. Pearce et al. [19] proposed on a model that would enable innovative collaboration and communication in technology on a global scale.

E. AT and its Applications as Cases

The major application of appropriate technology can be witnessed as successful case studies post-2009. Vaccari et al. [30] developed an appropriate model of cooking stove for the rural population of Logone Valley (Chad-Cameroon) using fuels available locally and comparing traditional design models with the present design. Appropriate technology has helped a lot of sectors like information technology, environment and energy. To address the issue of groundwater contamination faced by different countries face, Murphy [17] extended the theme of appropriate technology for a better understanding and its implementation in the treatment and recycling of water. Kiani [16] analyzed various appropriate technologies to solve drinking water issues in which a qualitative analysis of various water treatment technologies was conducted to identify pollutants and ways of removing them. Sorlini et al. [26] discussed various technology transfer models that are relevant in present times and to determine the most efficient method, which they applied to the sugarcane industry. Waste management is a critical issue and requires attention. To address the issue of appropriate infrastructure to manage waste in slums, Joshi and Seay in their study [12], developed a processor aligned with the principle of appropriate technology and sustainability which would be able to generate usable fuel from plastic waste. Sugathan et al. [15] designed a knitting yarn from silk remnants available locally by using appropriate technology methods, which would provide employment to female workers of a village. Brown and Bauer [8] carried out research to help people find an appropriate technology who survived a natural calamity. Access to clean water was a burning issue in that disaster struck area. Therefore, gathering information from the community, an in-expensive filter was developed which was portable, easily reproduced and can be used by the community during times of disaster [8].

IV. APPROPRIATE TECHNOLOGY AND GRASSROOTS INNOVATION

Innovation in technology should be a driver of new alternatives, especially those which have a lesser impact on nature [7]. Appropriate technology is a sound technology which improves living standards and promotes industrialization in rural areas or least developing countries [4]. Campbell [11] posited that the design and conception of appropriate technology often require competency derived both from technology and social science.

Community action and innovation form the essence of sustainable development. Community action, being a major research area, provides a novel scope for studying innovation and this relation can be best studied with grassroots innovation. Grassroots innovation is a needs-based innovation that takes place at the bottom of the pyramid [21]. Like appropriate technology, grassroots innovation is generated from a resource constraint environment and it can be scaled up as it holds potential for low-income markets. The driving force for grassroots innovation is to meet social needs. Smith et al. [25] stated that grassroots innovation possesses an ability to furnish appropriate solutions as the innovators involved have in-depth knowledge of what would work best for local conditions. Some grassroots innovative practices can be converted into technologies, if these technologies can be commercialized and if it is appropriate to particular circumstances, then this technology can be considered as an Appropriate Technology [18].

V. CONCLUSION

Appropriate technology is an empowering technology which needs to be sustained so that it can be used in the future [23]. Ecology sustainability, technological innovation, community action and maintaining equity in society are some of the criteria that are needed to be maintained while selecting an appropriate technology. Lately, the term appropriate technology has once again started evolving in the literature. Many studies have successfully shown the usage and implementation of technology in less industrialized countries or rural places [8], [12], [15], [26], [30]. This study has made an attempt to demonstrate how appropriate technology is successfully solving various problems in different parts of the world. The potential of appropriate is yet untapped so it needs to be re-defined and conceptualized in the era of modern technological advancement for sustainability.

REFERENCES

- [1] Ahmad, A. (1989). Evaluating Appropriate Technologies for development: Before and After. *Evaluation Review*, Vol 13, No 3, 310-319.
- [2] Akubue, A. (2000). Appropriate technology for socio economic Development in third world countries. *Journal of Technology Studies*, 26(1).
- [3] Amiolemen, O.S., Ologe, O. I., Ogidan, A.J. (2012). Climate Change and Sustainable Development: The Appropriate Technology Concept. *Journal of Sustainable Development*, 5, 5.
- [4] Beder, S. (1994). The role of technology in sustainable development. *IEEE Technology and Society Magazine*, 13(4), 14-19.
- [5] Bolay, J-C. (2012). Appropriate Technologies for Sustainable Development. *Technologies and Innovations for Development*, DOI 10.1007/978-2-8178-0268-8_1, Springer-Verlag, France.
- [6] Bowonder, B. (1979). Appropriate Technology for Developing Countries: Some Issues, *Technological Forecasting and Social Change*, 55-67.
- [7] Brandão Santana, N., Rebelatto, D. A. D. N., Périco, A. E., Morales, H. F., & Leal Filho, W. (2015). Technological innovation for sustainable development: an analysis of different types of impacts for countries in the BRICS and G7 groups. *International Journal of Sustainable Development & World Ecology*, 22(5), 425-436
- [8] Brown, A. and Bauer, M.A. (2016). Remotely designed Appropriate Technology for Emergency Disaster Response in Nepal. *Procedia Engineering* 159, 275 – 283.
- [9] Bruun, P., and Mefford, R. N. (1996). A framework for selecting and introducing appropriate production technology in developing countries. *International Journal of Production Economics*, 46, 197-209.
- [10] Buitenhuis, J., and Pearce, J. M. (2010, January). Open design-based strategies to enhance appropriate technology development. In *National Collegiate Inventors and Innovators Alliance. Proceedings of the... Annual Conference* (p. 1). National Collegiate Inventors & Innovators Alliance.
- [11] Campbell, P. A. (1975). Appropriate technology innovation for rural industrialisation in LDCs.
- [12] Joshi, A.C and Seay, R.J. (2016). An Appropriate Technology Based Solution to Convert Waste Plastic into Fuel Oil in Underdeveloped Regions. *Journal of Sustainable Development*; 9, 4. Canadian Center of Science and Education.
- [13] Kerr, C. (1988). Community water development. In *Community water development*. Intermediate Technology Publications Ltd.
- [14] Lissenden, J., Maley, S., & Mehta, K. (2015). An Era of Appropriate Technology: Evolutions, Oversights and Opportunities. *Journal of Humanitarian Engineering*, 3(1), 8-16.
- [15] Manju Sugathan, Tom Cassidy, Bruce Carnie. (2016), "The development and evaluation of a speciality hand knitting yarn using appropriate technology for the empowerment of women in rural India ", *Research Journal of Textile and Apparel*, Vol. 20 Iss 3, pp. 136 – 154.
- [16] Mehdi Kiani, Department of Management of Technology, Islamic Azad University, Science and Research branch, Tehran, Iran *Danish journal of Management and Business Sciences*, 60-66, 2015.
- [17] Murphy, H. M., Edward, A. Mc., Farahbakhsh, K., (2009). Appropriate technology – A comprehensive approach for water and sanitation in the developing world, *Technology in Society*, 31, 158–167.
- [18] Pattnaik, B. K., and Dhal, D. (2015). Mobilizing from appropriate technologies to sustainable technologies based on grassroots innovations. *Technology in Society*, 40, 93-110.
- [19] Pearce, J. M., Albritton, S., Grant, G., Steed, G., and Zelenika, I. (2012). A new model for enabling innovation in appropriate technology for sustainable development.
- [20] Schumacher, E. F. (1973). *Small is beautiful: a study of economics as if people really mattered*. Blond & Briggs.
- [21] Seyfang, G., and Smith, A. (2007). Grassroots innovations for sustainable development: towards a new research and policy agenda. *Environmental Politics*, 584-603.
- [22] Sianipar, C. P. M., Yudoko, G., Dowaki, K., & Adhiutama, A. (2014). Design and technological appropriateness: The quest for community survivability. *Journal of Sustainability Science and Management*, 9(1), 1-17.
- [23] Sianipar, C. P., Yudoko, G., Dowaki, K., and Adhiutama, A. (2013). Design methodology for appropriate technology: Engineering as if people mattered. *Sustainability*, 5(8), 3382-3425.
- [24] Sianipar, CPM., Yudoko, G., Adhiutama A, Dowaki, K. 2013b. Community empowerment through appropriate technology: sustaining the sustainable development. *Procedia Environmental Sciences*, 17, 1007–1016.
- [25] Smith, A., Fressoli, M., Abrol, D., Arond, E., and Ely, A. (2016). *Grassroots innovation movements*. Routledge.
- [26] Sorlini, S., Rondi, L., Gomez, A. P., & Collivignarelli, C. (2015). Appropriate technologies for drinking water treatment in Mediterranean countries. *Environmental Engineering and Management Journal*, 14(7), 1721-1733.
- [27] TA, C. (2014, May). A. De Giorgio, G. Ingravallo and C. Roveda". In *Criteria for Selecting Appropriate Technologies under Different Cultural, Technical and Social Conditions: Proceedings of the IFAC Symposium Bari, Italy, 21-23 May 1979* (p. 169). Elsevier.
- [28] Tahmooresnejad, L., Salami, R., and Shafia, M. (2011). Selecting the

- appropriate technology transfer method to reach the technology localization. In *Proceedings of the World Congress on Engineering* (Vol. 1).
- [29] Teitel, S. (1978). On the Concept of Appropriate Technology for Less Industrialized Countries, *Technological Forecasting and Social Change*, 11, 349-369.
- [30] Vaccari, M., Vitali F, Mazzu A. (2012). Improved cook-stove as an appropriate technology for the Logone Valley (Chad-Cameroon): Analysis of fuel and cost savings. *Renewable Energy* 47, 45– 54.
- [31] Wicklein, R. C. (1998). Designing for Appropriate Technology in Developing Countries, *Technology in Society*, 20,371-375.
- [32] Willoughby, K. W. (1990). *Technology choice: A critique of the appropriate technology movement*. Dr Kelvin Wayne Willoughby.
- [33] Zelenika, I., and Pearce, J. M. (2011). Barriers to Appropriate Technology Growth in Sustainable Development. *Journal of Sustainable Development*, 4(6), 12–22.