

REVIEW OF KNOWLEDGE AND TECHNOLOGY TRANSFER PROGRAM IN DEVELOPING ECONOMIES (WITH CASE STUDY IN METAL BASED SMES IN INDONESIA)

Fourry Handoko¹⁾, Ellysa Nursanti²⁾, Endah Kusuma Rastini³⁾, Prima Vitasari⁴⁾
Industrial Engineering, National Institute of Technology (ITN) Malang, Indonesia^{1,2,4)}
Mechanical Engineering, National Institute of Technology (ITN) Malang, Indonesia³⁾

Abstract This paper describes the literature review on knowledge and technology program. It concisely articulates: Technology, Knowledge, Technology Transfer, The role of Technology transfer, and SMEs in Indonesia, with particular issue of metal based SMEs in Pasuruan, based of fieldwork research finding. This paper explore technology and technology transfer in general, providing an overall picture regarding these and other related issues. This review shows that many issues relating to technology transfer have been emerging for some decades. However, the review concentrates on the historical chronology of issues that have led to the experience of technology transfer for SMEs in developing countries.

Keywords: Developing Countries, Knowledge, Technology, Technology Transfer

1. Introduction

This research begins by exploring technology and technology transfer in general, providing an overall picture regarding these and other related issues. The literature shows that many issues relating to technology transfer have been emerging for some decades. However, in order to maintain its focus on the main purpose of this research, the review concentrates on the historical chronology of issues that have led to the problem of sustainable technology transfer for SMEs in developing countries. Accordingly, this paper summarises the key issues from the literature and discusses them in this order (1) introduction (2) technology; (3) knowledge; (4) technology transfer; (5) SMEs in Indonesia (6) Study about Technology transfer for SMEs in Pasuruan Indonesia and (7) Conclusion.

2. Technology

It is important to understand what is meant by technology. It has been given various definitions. Technology can be defined as all the knowledge, products, processes, tools, methods, and systems employed in the creation of goods or providing services [1].

Stewart [2] has provided a broad definition of technology by including all skills, knowledge and procedures required for making, using, and doing useful things.

Sahal, one of the few theorists who has written about concepts of technology, refers to technology as 'configuration', observing that the transfer object, the 'technology', must rely on a subjectively determined but specifiabile set of process and product [3]. Merely focusing on the product is not sufficient to the study of transfer and diffusion of technology; it is not merely the product that is transferred but also knowledge of its use and application [4]. This approach resolves a major analytical problem: the difference between technology and knowledge transfer. In Sahal's concept the two are not separable. It means that when a technological product is transferred, the knowledge upon which its composition is based is also transferred [3].

* Corresponding author. Email: fourry.handoko@scholar.itn.ac.id

Published online at <http://Jemis.ub.ac.id>

Copyright ©2022 DTI UB Publishing. All Rights Reserved

3. Knowledge

According to Nonaka [5], Western philosophers have generally agreed that knowledge is ‘justified true belief’. There are two great epistemological traditions in Western philosophy: Rationalism and Empiricism. Rationalism argues that true knowledge is not the product of sensory experience, but rather of ideal mental process. On the contrary, empiricism states that there is no *a priori* knowledge and that the only source of knowledge is sensory experience.

Knowledge is a fluid mix of frame experience, values, contextual information and expert insight that provides a framework for evaluating and incorporating new experiences information [6]. This argumentation shows that knowledge can only exist in the context of a person and his beliefs and experience [5].

3.1 Different types of knowledge

The first distinction is between declarative knowledge (what), which is associated with facts and procedural knowledge (how), for example, how to ride a bicycle [7–9]. Cognitive neuroscientists use the terms declarative to refer to memory of facts and events [9]. Declarative knowledge focuses on beliefs about relationships among variables. For example, hunter-gatherers know about edible plants and where they can be found [10]. Procedural knowledge, conversely, according to Becerra and colleagues [11], ‘focuses on beliefs relating sequences of steps or actions to desired (or undesired) outcomes’. For instance, ‘the set of justified beliefs about the procedure that should be followed in a government organisation in deciding to whom to award the contract for a particular area, for example, information system development’ [11].

2.2 Tacit knowledge and explicit knowledge

Another essential classification of knowledge views it as either tacit or explicit [5, 12]. Explicit knowledge is easier to be transferred and also amenable to the written page, expressed in words and numbers or put into symbolic form [11, 13, 14]. For example, written instructions, procedures, statistical data, designs and specification, standards. It makes the problem of communication and cultural transfer is usually less because fewer personal contacts need to be involved between transferor and transferee and also reducing transference costs compared with the situation when

participants have to spend money for training or learning [15, 16]. But in transferring explicit knowledge, problems occurs because of a lack of familiarity with using codifying methods or a different way of codification [13]. In the process of transferring, transferor and transferee are forced to adopt a common language or communication code, which can be used to transfer technical material and/or to discuss technical issues.

In contrast, tacit knowledge, the type of knowledge that is difficult to express and formalise, and therefore difficult to share, includes insights, intuitions, and experiences. [11]. Popper [17], is deeply embedded in personal beliefs, attitudes, values and experiences, which give tacit knowledge its meaning. Such knowledge would be considered tacit, unless the analyst can verbalize it in the form of a document that others can use and learn from.

However, even though the explicit and tacit forms of knowledge are quite distinct, it is possible to convert explicit knowledge into tacit [5]. According to Becerra et al [11], by reading a particular book, it is possible an individual converting the codified knowledge into tacit knowledge in the individual’s mind after learns from the book. In similar, tacit knowledge also could be transform into explicit knowledge, when an individual writes a book formalizing their tacit knowledge [11].

4. Technology transfer

Technology transfer may simply be the movement of technology from one location to another, from one use to another, or a combination of the two [18]. Roessner in Bozeman [3] defines technology transfer as the movement of know-how, technical knowledge, or technology from one organisation setting to another.

Technology transfer can also be defined in many ways that differ according to the discipline of the research project [3] including green technology [19, 20]. Zhao and Reisman [21] reviewed the definitions of technology transfer as differing substantially between disciplines. For instance economists [22–24] defined technology on the basis of properties of generic knowledge, focusing particularly on variables that relate to production and design. Sociologists [25, 26], tended to link technology transfer to innovation and to view technology transfer as

including social technology.

Naito [27] deduced four elements of the technology transfer process: human resources, information, machinery and material resources, and capital. In the human resources element, the process of technology transfer involves the exchange of expertise. Expertise transfer of knowledge to transferees facilitates 'know how' learning and administrative skills. The information element is related to providing information about development or design of the technology and related embodied skills, such as production skills. In terms of the resource elements, the transferor is responsible to provide the transferee with materials (machinery and equipment) and methods (capability for development, experiment). Regarding capital elements, both transferor and transferee can transfer technology, either through joint ventures or industrial co-operation [28]. Of importance is deciding when the technology transfer is complete. The technology transfer is not complete until the transferee can adapt, operate, maintain and innovate the technology. In this sense, technology transfer is not just acquiring knowledge, but also building up technological capability [29].

4.1 The role of technology transfer

In a period of rapid change and high competitiveness, technology plays a vital role in supporting a firm's performance. By elevating transferee technology capability during a technology transfer program, the transformation process inside the firm becomes more effective and efficient. Ultimately, the chance to develop low-cost production, better performance products and earlier availability, will impact on an organisation's competitiveness. Improved methods for production, inventory control, material handling, quality assurance and technology may provide both direct and indirect benefits that result in a more competitive company [30]. The following section will discuss the issues associated with technology transfer to improve technology capability.

5. Small to Medium Enterprises in Indonesia

SMEs are considered very important to the Indonesian economy [19, 31–33]. They have the capability to create employment, and are a valuable source of economic growth [34]. As such, SMEs are important when completing a broad investigation into the process of

industrialization [35]. The reasons why SMEs are an important subject in Indonesia include [35]:

1. SMEs play a pivotal role in generating an economy's development.
2. SMEs are a clear and consistently enunciated Indonesian government main concern. The government has given high priorities to SMEs for some decades.
3. Owing to impartiality issues – most likely because ethnic relations are very sensitive politically in Indonesia – SMEs have been used in promoting indigenous Indonesian business.
4. The imperative to formulate economy policy because it cannot be assumed that the same policies that are created for larger industrial units will necessarily apply to SMEs, because of SMEs-specific characteristics such as higher concentrations within particular industry sectors and less foreign ownership
5. The international experience indicates that efficient SMEs generate industrial growth and a flexible industrial structure. Taiwan often is held out as an example of an economy built on the foundations of an efficient SME sector [35].
6. It is considered that SMEs in Indonesia are better able to accommodate economic crises than LEs.

During the Asian economic crisis of 1997, SMEs demonstrated a greater capacity to continue operationing compared to LEs because of their flexibility in adjusting production processes in response to changing market demand, even though the economic changes were sudden [34]. During this crisis, SMEs in Indonesia were able to quickly change to new products and/or production settings. SMEs effectively used their existing linkages, and switched products to supply different market segments (e.g. the replacement market and the import substitution market) [36]. Regarding cost reduction in response to the economic crisis, SMEs increased their employment of school trainees to minimize their overall salary costs [36].

Despite their important role in domestic economic and industrial development in Indonesia, SMEs increasingly have to actively compete in both regional and international trading markets. This is an environment with complex relationships, rapid technology enhancement, and competition [37]. In

Indonesia, most SMEs operate using traditional methods of production and marketing [38]. Lack of technological, managerial and marketing knowledge, and poor access to finance are the main impediments facing SMEs in Indonesia and elsewhere [39]. This lack of capital, lack of skills and lack of capabilities in business development are common problems for Indonesian SMEs. However, as other governments in the world have done to support SMEs in their countries [40], the Indonesian government, through its “Ministry for Cooperative and SMEs” have supported domestic SMEs by launching many programs, including programs associated with technology transfer and financial support.

5.1 Previous research on SMEs in Indonesia

Few studies on Indonesian SMEs are published in the available literature. Some journal articles report case study investigations into SMEs using surveys [35]. Berry colleagues [41] investigated export-oriented furniture manufacturing SMEs in the town of Jepara, northern Central Java [35]. Case studies of furniture manufacturing SMEs by Sandee et al [41] concluded that the enterprises surveyed, on average, actually expanding during the prior economic crisis. In the automotive and machined industry sectors, Harianto (in Hill [35]) investigated emerging subcontracting networks. Hayashi [42] completed similar research in collaboration with the Japan International Cooperation Agency (JICA) and Indonesia Ministry of Industry and Trade (MOIT), where subcontracting by LEs to SMEs was investigated. Hayashi found strong subcontracting relationships within assembly and supply company domains, especially in business sectors with a technology focus. Sato [36] focused on the Javanese metal casting industry ‘cluster’ to investigate the ability of metal casting SMEs to endure the preceding Asian economic crisis. Sato found that, for example, the associated subcontracting system in this cluster accommodated linkages with enterprises outside the cluster, for example, wholesaler companies.

There are also few published studies on transfer technology in Indonesia. Kumar and colleagues [43] explored the relationship between international technology transfer and the cultivation of indigenous technology capability within the Indonesian manufacturing

cluster, involving 45 corporate participants. Sandee and Rietveld [41] focused on innovation adoption in the roof tile cluster in Karanggeneng, Central Java, where 32 technology adopters were surveyed over an extended period. The study concluded that clustering makes it possible to adopt relevant new technology in a staged manner where SMEs can accommodate the associated risk through sharing the cost and risks of the technology adoption [44]. Tambunan [45, 46] investigated the role of government in a technology transfer program to a SME cluster. Tambunan’s research involved surveying 34 SME participants using interview and focus group discussion in the town of Tegal, Central Java. This study demonstrated that the role of government in technology transfer programs facilitates interactions between distinct SMEs by reducing the ‘search cost’ associated with finding suitable partner organisations. Both SMEs and LEs found that the government-facilitated technology transfer and associated technical training could be beneficial [45]. Tambunan [46] studied the promotion of innovation in SMEs through the transfer of technology, also in Tegal, Central Java. Tambunan investigated the transfer of technology from multinational companies to two successful local subcontracting SMEs [46].

6. Study about Technology Transfer in Pasuruan, East Java, Indonesia

Pasuruan is a coastal city in the Indonesian province of East Java where a large number of SMEs are located, with a significant proportion manufacturing metal goods in particular non-ferrous metals and electroplating. But we also found a foundry located in Pasuruan. Even the majority of SMEs in Pasuruan were small, in Pasuruan, East Java SMEs are involved in the manufacture of motorbike and car accessories (examples observed by the author include hand brakes, machine block covers, lamp covers and front grills) to support FDI manufacturing or others large companies. Regarding to human power, based on the finding in the fieldwork in Pasuruan, the number of employees in each SME approximately about under 20, with education levels of both the owners and the employees in Pasuruan is vary from elementary education at best (for olders owners and employee), to university bachelor’s degree (for most younger owners and employees). During interviews, government

agencies have supported knowledge and technology by providing equipment, and training programs. Government have initiated perpetual technology transfer programs that usually conducted from one to ten or more years. The transferor agents focus on human resources development through training programs by facilitating exchange and placement of technicians and engineers. A simple administration bureaucracy for new SMEs to operate that applied by government shows the good willing of government in Supporting SMEs. Local government also provided a free consultation regarding technical issue related knowledge.

6.1. Informal technology transfer

During fieldwork, it was identified that SMEs in Pasuruan also experienced informal knowledge technology transfers through knowledge transfer amongst workers, especially workers in large companies who have spread their knowledge within their local communities. In some cases, with support from large companies, workers in those companies founded metal-based SMEs. This sharing knowledge and information among those who have worked in large metal-based companies, effectively improve the SME community technology capability and their knowledge capacity.

7. Conclusion

The broad literature on technology transfer has been reviewed and the salient features of the field relevant to knowledge technology transfer have been synthesized. Technology transfer *per se* has been found to be a fruitful research area [1, 3, 31, 32, 40, 47], including issues associated with knowledge management [5, 11]. Overall, however, an extensive survey of the publicly available literature has found few publications that address the explicit needs of SMEs in developing countries. As such, issues associated with technology transfer and SMEs in developing countries, in particular Indonesia, has been adopted as a knowledge to strengthen the study regarding knowledge and technology transfer in Indonesia.

Using the available literature of previous studies, this research investigates the knowledge and technology transfer Program in Pasuruan East Java, Indonesia. The finding shows that the government has concern in technology and

transfer programs for SMEs in Pasuruan. In this research also identified that SMEs in Pasuruan experienced some informal technology transfer programs due to the involvement and commitment of large company and their workers in knowledge and technology transfer sharing, amongst their community and also inter-community of SMEs.

References

- [1] Khalil. *The Key to Competitiveness and Wealth Creation*. Mc.Graw Hill, 2000.
- [2] Stewart F. Technology and Underdevelopment. *Dev Policy Rev*; A10. Epub ahead of print 1977. DOI: <https://doi.org/10.1111/j.1467-7679.1977.tb00260.x>.
- [3] Bozeman B. Technology transfer and public policy: A review of research and theory. *Res Policy* 2000; 29: 627–655.
- [4] Sahal D. Alternative conceptions of technology. *Res Policy* 1981; 10: 2–24.
- [5] Nonaka I, Takeuchi H. *The Knowledge Creating Company: How Japanese Companies Create the Dynamics of Innovation?* New York: Oxford University Press, 1995.
- [6] Davenport, T.H., Prusak L. *Working Knowledge: How Organizations Manage What They Know*. Boston: Harvard Business School Press, 1998.
- [7] Singley M, Anderson J. *The Transfer of Cognitive Skill*. Cambridge: Harvard Press, 1989.
- [8] Kogut B, Zander U. Knowledge of the firm, combinative capabilities and the replication of technology. *Organ Sci* 1992; 3: 383–397.
- [9] Gorman ME. Types of Knowledge and Their Roles in Technology Transfer. *J Technol Transf* 2002; 27: 219–231.
- [10] Mathews RC, Roussel LG. Abstractness of Implicit Knowledge: A Cognitive Evolutionary

- Perspective. In: (Eds.) DCB (ed) *How implicit is implicit learning?* Oxford: Oxford University Press, 1997.
- [11] Becerra-Fernandez, Irma., Gonzales, Avelino., Sabherwal R. *Knowledge management: Challenges, solutions, and technologies*. New Jersey: Pearson Prentice Hall, 2004.
- [12] Polanyi M. *The Tacit Dimension*. London: Routledge and Keoan, 1996.
- [13] Marcotte C, Niosi J. Technology Transfer to China. The Issues of Knowledge and Learning. *J Technol Transf* 2000; 25: 43–57.
- [14] Weiss D. The Relationship between a firm's level of technical innovativeness and its patterns of partnership agreements. *Manage Sci* 2002; 43: 343–356.
- [15] Williamson O. Transaction-Cost Economics. The Governance of Contractual Relation. *J Law Econ* 1979; 22: 233–262.
- [16] Williamson O. The Economics of Organisation : The Transaction Cost Approach. *Am J Sociol* 1981; 87: 548–577.
- [17] K. P. *Objective Knowledge: An Evolutionary Approach*. Clarendon Press: Oxford, 1972.
- [18] Kremic T. Technology Transfer: A Contextual Approach. *J Technol Transf* 2003; 28: 149–158.
- [19] Handoko F, Nursanti E, Tjahjadi ME, et al. Green Industrial System in Indonesia. Matec Web of Conferences, p. 164.
- [20] Handoko F, Paula C, Hidayat S, et al. A green-based manufacturing system to solve pallet shortage problems. *Heliyon* 2021; 7: e06823.
- [21] Zhao LM, Reisman A. Toward meta research on technology-transfer. *IEEE Trans Eng Manag* 1992; 39: 13–21.
- [22] Arrow K. Classificatory notes on the production and transmission of technological knowledge. In: *American Economic Review, Papers and Proceedings*. 1969, pp. 244–250.
- [23] Johnson H. *The efficiency and welfare implications of the international corporation*. International Corporations. Cambridge Univ. Press, 1970.
- [24] Dosi G. *The nature of the innovation process*. London: Pinter Publishers, 1998.
- [25] Rogers EM. *Diffusion of Innovations*. New York: The Free Press of Glencoe, 1962.
- [26] Rogers EM, Shoemaker FF. *Communication of Innovations: A Cross Cultural Approach*. New York: Free Press, 1971.
- [27] Naito Y. *System innovation: technology transfer*. Enterprise Diagnosis, 1989.
- [28] Hong J. Technology Transfer and Human Resource Development. *Ind Commer Train* 1994; 26: 17–21.
- [29] Chen EKY. Introduction: Transnational Corporations and Technology Transfer to Developing Countries. *United Nations Libr Transnatl Corp*; 18.
- [30] Porter ME. *Competitive Advantage*. New York: Free Press, 2008.
- [31] Handoko F, Alan S, Burvill C. The Role of Government, Universities, and Business in Advancing Technology for SMEs' innovation. *J Chinese Econ Bus Stud* 2014; 12: 171–180.
- [32] Handoko F, Nursanti E, Harmanto D, et al. The role of tacit and codified knowledge within technology transfer program on technology adaptation. *ARN J Eng Appl Sci* 2016; 11: 5275–5282.
- [33] Hidayat S, Handoko F, Tjahjadi ME, et al. The Triple Helix and Technology Capability and Competitiveness of SMEs in Developing Economy. *Int J Civ Eng Technol* 2018; 9: 366–378.
- [34] Tambunan T. Promoting Small and Medium Enterprises with a

- Clustering Approach: A Policy Experience from Indonesia. *J Small Bus Manag* 2005; 43: 138.
- [35] Hill. Small and Medium Enterprises in Indonesia: Old Policy Challenges for a New Administration. *Asian Surv* 2001; 41: 248–270.
- [36] Sato Y. How did the crisis affect small and mediumsized enterprises? From a field study of the metal-working industry in Java. *Dev Econ* 2000; 38: 572–595.
- [37] Sandvig JC. The Role of Technology in Small Firm Diversification. *J Technol Transf* 2000; 25: 157–168.
- [38] Hasan MM, Yajuan L, Khan S. Promoting China’s inclusive finance through digital financial services. *Glob Bus Rev* 2020; February: 1–23.
- [39] Berry, A., and Mazumdar D. Small-scale industry in the Asian-Pacific region. *Asia Pac Econ Lit* 1991; 5: 35–67.
- [40] Handoko F, Vitasari P, Hidayat S, et al. Technology transfer program for SMEs in Indonesia. In: *Journal of Physics: Conference Series*. Institute of Physics Publishing, p. 12053.
- [41] Berry, Rodriquez S. Small and Medium Enterprise dynamics in Indonesia. *Bull Indones Econ Stud* 2001; 37: 363–384.
- [42] Hayashi M. The role of subcontracting in SME development in Indonesia: Micro-level evidence from the metalworking and machinery industry. *J Asian Econ* 2002; 13: 1–26.
- [43] Kumar. Building Technological Capability through Importing Technology: the Case of Indonesian Manufacturing Industries. *J Technol Transf* 1999; 24: 81–96.
- [44] Sandee H, Piet R. Upgrading traditional technologies in small-scale industry clusters: Collaboration and innovation adoption in Indonesia. *J Dev Stud* 2001; 37: 150–173.
- [45] Tambunan T. Entrepreneurship Development: SMEs In Indonesia. *J Dev Entrep* 2007; 12: 95–118.
- [46] Tambunan T. Development of small and medium enterprises in a developing country: The Indonesian case. *J Enterprising Communities People Places Glob Econ* 2011; 5: 68–82.
- [47] Handoko F. Constructing Knowledge and Technology Transfer Model for SMEs Technology Development in Emerging Economies. *Int J Pedagog Teach Educ* 2017; 1: 93–107.