

# THE ROLE OF TRANSFERORS IN IMPROVING SMES' TECHNOLOGY CAPABILITY IN DEVELOPING COUNTRIES

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***Abstract***—Technology transfer has widely been considered as a means of improving technology capability. Organisations across the world have been involved in technology transfer programs. In developing countries, small to medium enterprises (SMEs) are regarded as a valuable source of economic growth. However, SMEs are also often thought to have insufficient resources to advance their in-house technology development. Therefore, SMEs require technology transfer programs to increase their technology capability. Numerous technology transfer programs have been applied through government agencies, universities and businesses to improve SMEs technology capability. This study provides empirical data to explain the role of transferors (government, universities, businesses) in the transfer of technology for SMEs. With more than 200 respondents, the results of this study illuminate the involvement of the SMEs in technology transfer programs and role of the transferors in transferring technology.

***Keywords***—Knowledge and Technology Transfer, Technology Capability, Transferor, SMEs.

## I. INTRODUCTION

For decades, businesses in developed economies faced a paradigm where resource-based competitiveness was replaced by knowledge-based competitiveness (Drucker, 1994). Since knowledge and technology have created prosperity and traditional factors such as land, human labour, and natural resources are issues that have lessened in importance, having been displaced by human resource development and knowledge-technological capability. Developed countries have been successful in managing knowledge as the most vital resource of today's enterprises. In contrast, small to medium enterprises (SMEs) in developing countries (such as Indonesia) face an increasingly complex external environment due to rapid technological change and progressively sophisticated competitors. It is

necessary to accelerate their organisational knowledge and use of technology to successfully compete (Handoko et al., 2014; 2016; 2017; 2017; 2018). According to Tambunan (2005), Indonesia considers SMEs important as they have capability to create employment and are a valuable source of economic growth and foreign currency. Moreover, during the Asian economic crisis in 1997, SMEs demonstrated a greater capacity to continue operations when compared to large enterprises because of their flexibility in adjusting production processes in response to changing market demand, despite sudden economic changes. Small-scale industries increasingly have to compete in both regional and international trading markets. Trading markets are environments with complex relationships, rapid technology enhancement, and competition. The ability of SMEs to commercialise technology improvements is essential in highly competitive and rapidly changing markets. Successful small-scale industries rely upon their technology capabilities to provide a competitive advantage (Sandvig, 2000).

Knowledge and technology play an essential part in this rapid response capability by maintaining the opportunities for continuous improvement and innovation needed in the development of sustainable competitive advantage (Cavusgil et al., 2003; Wijayaningtyas and Sipan, 2016). However, the low capability of SMEs to provide the necessary resources (e.g. human resources and facilitating technologies) is a barrier to the in-house development of their technological capability. Consequently, external resources to support their development of technological capabilities, so-called 'knowledge and technology transfer' programs are required (Marcotte and Niosi, 2000; Gorman, 2002; Hidayat et al., 2018). New technology that improves the long-term capability of a company is likely to encourage continuous knowledge and technology transfer (Tjahjady et al., 2017; 2017; 2017). The aim of this study was to discover the role of the transferors including the government, universities, businesses, and interplay among transferors in the

transfer of technology within the context of SMEs in a developing economy, with a particular focus in Indonesia.

## II. LITERATURE REVIEW

Some researchers argue that technology transfer does not have a single universal meaning; for example, simply moving a computer from a university in Boston to a university in Manila can be defined as technology transfer (Kremic, 2003). Its literal meaning infers that 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. Roessner (in Bozeman, 2000) defines technology transfer as the movement of know-how, technical knowledge, or technology from one organisation setting to another.

Defining the moment at which technology transfer is complete is important. 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 the acquisition of knowledge, but also the increase of technological capability (Chen, 1994). In order to allow technology transfer to take root, it must be performed on a sustainable basis. For example, this could be technology transfer through human involvement, elevating the transferee technology capability. The interaction of elements, both hardware and software, are considered important factors for effective technology transfer. These elements form the focus of the current research.

In a period of rapid change and 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 a low-cost production, quality performance products and an 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 (Porter, 2008).

## III. METHODS

In this research study, the survey research method was selected and distribute the questionnaire with personal interview. This method was developed to deal with a fraction of the total population. The most common form of the survey was the self-administered mail questionnaire, although other methods such as the telephone survey and personal interviews were used. This survey gathered 250 respondents of SME managers or owners in Java, Indonesia.

Although this research was applied to SMEs, the structure of the sector in Java meant that it was possible that one person (or a number of closely related persons)

could answer for more than one company. For example, one family had five different SMEs, each managed by a different son. To avoid the same respondent completing a survey for more than one SME, the samples were revised to ensure that only one site per respondent was chosen as a sample. Besides choosing the level of the organisation, another issue related to the level of analysis was the selection of the member of the organisation to complete the questionnaires. Ideally, the questionnaires should be completed by a number of people in each part of an organisation to minimize individual response bias and to allow an aggregate measure for all organisations (Flynn et al., 1994). However, this research was conducted in SMEs simple in nature due to the plain structure of organisation hierarchy. This led to the option to survey either the manager, the owner, or the person responsible for KTT programs. In this survey, the preferred individual to complete the questionnaires was the person responsible for the KTT program of the organisation.

The reason for members of the sample originating in Central Java and East Java areas is provided. The database developed from the preliminary fieldwork research was utilised to determine the potential respondents. From about 800 prospective respondents' areas, more than 200 were randomly selected. The respondents were checked to ensure they only belonged to one SME included in the sample.

The development of the measurement instrument began with derivation of the constructs of technology transfer. The areas relevant in the support of the technology transfer program were also included. Using the psychometric approach, measurement items that encapsulated the core ideas of the constructs were developed. All constructs had multiple items. The draft instruments were pretested with experts and then subjected to pilot testing with a sample of metal-based SMEs organisations. As the pilot study involved a small sample size, tests for reliability and validity were conducted. This approach was taken to ensure that the measurement instrument was capable of measuring what was intended to be measured. For all items, Cronbach's alpha coefficient values were greater than the acceptable value of 0.6 (Hair, 2010), indicating that the items assigned to the constructs were reliable. Eventually, the final measurement instrument was developed. The most popular scales applied by researchers are the Likert, Guttman, and Thurstone scales. In this research, the Likert scale was chosen to measure all items. The construct, indicators, and measurement items were adopted and modified from previous studies to measure the transferor, technology capability, and competitiveness dimension in this study. These items reflect the level of the transferor in transferring technology.

To provide perspective about Indonesian SMEs, fieldwork was conducted to provide information about target areas of Ceper and Pasuruan, both in Java. Ceper

and Pasuruan are regions of metal-based SME clusters that can be used as role models of technology transfer programs for SMEs in developing countries. The metal goods SMEs in those areas have been established for decades and have experience with technology transfer programs. The metal goods SMEs have characteristics such as clustering in a geographic location, flexible industrial structures, and decreased government interference and/or foreign ownership. These characteristics are common among SMEs in other industry sectors within Indonesia as well as in other developing countries. Those districts in the Indonesian province of Central Java and East Java were homes to a significant number of SMEs in the metal goods industry sector. Ceper and Pasuruan were found to be the largest foundry cluster in Indonesia.

**IV. RESULTS AND DISCUSSION**

This section analyses the participating organisation responses based on categories of items presented in the final form of the measurement instrument. Since the ordinal data used the five-point Likert measuring scale, the median is used as the primary measure of central tendencies and percentiles (25, 50, and 75) are calculated as measures of dispersion, as is recommended for this data type (Matre and Gilberth, 1987 as cited in Singh, 2002). However, much of the applied psychology/organisational studies in the available literature treat Likert scales to produce interval type data (Singh, 2002). Therefore, mean and standard deviation measures were also measured for all the items in this research.

Successful approaches to technology transfer emphasize the crucial role of transferors in enabling an organisation technology transfer program (Bozeman, 2000). Aspects of the transferor’s role were measured along eight dimensions (items 1-8 in Table 1). Respondents were asked to express their level of agreement with the items using a numerical scale. The responses could range from 1 = strongly disagree to 5 = strongly agree from the participant, in terms of the adequacy of the transferor’s actions to meet the technology transfer requirements of their organisation.

The results contained in Table 1 show that for 4 dimensions (items 3, 4, 5, and 6) the middle response corresponds with “agree” (median = 4), and 4 others (items 1, 2, 7, and 8) the middle ranking were “neutral” (median = 3). Items 1, 2, 7, and 8 in Table 1 show a “neutral” overall response from participants, where a participant offered a mixed opinion about the items associated with responsibility, appropriate project terms, industry visits and sufficient feedback offered by government transferors.

**TABLE 1. THE GOVERNMENT**

Item	Median	Percentiles			Mean	Std. Dev
		25	50	75		
1. Responsibility and control	3	2	3	4	3.19	1.03
2. Project terms	3	3	3	4	3.45	0.90
3. Effective communication	4	3	4	4	3.54	0.90
4. Conference or meeting program	4	3	4	4	3.57	0.90
5. Sufficient personnel exchange programs	4	3	4	5	3.51	1.09
6. Sufficient workshop programs	4	3	4	4	3.58	0.92
7. Industry visits	3	3	3	4	3.28	1.08
8. Feedback	3	2	3	4	3.10	1.11

Scale: 1 = Strongly disagree; 2 = Disagree; 3 = Neutral;

4 = Agree; 5 = Strongly agree

The respondents expressed an overall “agree” opinion in regard to the value of items associated with effective communication, the meeting program, the personnel exchange program, and the workshop program (items 3, 4, 5, and 6). It is clear that the “agree” option is dominant in respondent expression particularly in opinions about a personal exchange program (Item 5). Also, the number of respondents who ‘agree’ with the value of items associated with sufficient responsibility (item 1) and the sufficient feedback encouraged by government (item 8) are approximately equal with the respondents who ‘do not agree’. Overall, the respondents ‘agree’ that the transferor manner and style support sufficient knowledge and technology transfer for their organisations (item 3, 4, 5, and 6).

**TABLE 2. THE BUSINESSES**

Item	Median	Percentiles			Mean	Std. Dev
		25	50	75		
1. Responsibility and control	3	3	3	4	3.37	0.86
2. Project terms	4	3	4	4	3.51	0.78
3. Effective communication	4	3	4	4	3.62	0.88
4. Conference or meeting program	3	3	3	4	3.50	0.87
5. Sufficient personnel exchange programs	3	3	3	4	3.27	0.94
6. Sufficient workshop programs	4	3	4	4	3.63	0.91
7. Industry visits	3	3	3	4	3.35	0.96
8. Feedback	3	3	3	4	3.42	0.99

The results contained in Table 2 show that respondents tend to ‘agree’ (median = 4) with the survey statements associated with items 2, 3, and 6 and are ‘neutral’ to the statements associated with items 1, 4, 5, 7, and 8. The responses for item 2, 3, and 6 have a

negative skew, where the 50 and 75 percentiles were equal for the ‘agree’ response. This shows the respondents’ tendency to ‘agree’ in regard to the sufficiency of the project term, the effective communication, and the workshop program provided by business transferors. Overall, since the median response to the statement in items 1, 4, 5, 7, and 8 is ‘neutral’ and the median response to the statement in items 2, 3, and 6 is ‘agree’, it can be asserted that the respondents tend to ‘agree’ that the business transferors provide sufficient technology transfer programs.

**TABLE 3. THE UNIVERSITY**

Item	Median	Percentiles			Mean	Std. Dev
		25	50	75		
1. Responsibility and control	3	3	3	4	3.29	0.88
2. Project terms	3	3	3	4	3.42	0.80
3. Effective communication	4	3	4	4	3.55	0.89
4. Conference or meeting program	3	3	3	4	3.50	0.89
5. Sufficient personnel exchange programs	3	3	3	4	3.37	0.85
6. Sufficient workshop programs	3	3	3	4	3.50	0.82
7. Industry visits	3	3	3	4	3.45	0.84
8. Feedback	3	3	3	4	3.32	0.96

The results contained in Table 3 show that for most of the survey statements (i.e. items 1, 2, 4, 5, 6, 7, 8), respondents offered median ‘neutral’ responses. The one exception is for item 3, where the respondents offered a median ‘agree’ to the statement that universities offer sufficient communication in technology transfer programs. The respondents generally have a ‘neutral’ opinion about most of the items associated with the knowledge and technology transfer programs provided by the university transferors.

**TABLE 4. THE JOINT PROGRAM**

Item	Median	Percentiles			Mean	Std. Dev
		25	50	75		
1. Responsibility and control	3	2	3	4	3.21	1.10
2. Project terms	3	3	3	4	3.43	0.82
3. Effective communication	4	3	4	4	3.60	0.90
4. Conference or meeting program	4	3	4	4	3.61	0.92
5. Sufficient personnel exchange programs	3	3	3	4	3.23	1.02
6. Sufficient workshop programs	4	3	4	4	3.50	1.04
7. Industry visits	3	3	3	4	3.31	1.04
8. Feedback	3	3	3	4	3.32	1.12

The results contained in Table 4 show that for most of the survey statements (i.e. items 1, 2, 5, 7, and 8) respondents again offered median ‘neutral’ responses. Respondents offered a median ‘agree’ for items 3, 4, and 6. The results also show that opinion of the respondents for some items (3, 4, and 6) have negative skew. Overall,

since the median for all the items was 3 (neutral) and 4 (agree), it is asserted that the respondents tended to ‘agree’ that the transferor (joint program) offers knowledge and technology transfer benefits.

Comparing survey responses with respect to the transferors (government, business, university, joint program), the respondents offered similar overall responses to many of the items. Respondents expressed ‘agree’ in relation to the effective communication of the transferors (item 3). Respondents expressed mixed opinions on items 1, 7, and 8 (i.e. the responsibility, the industry visits, and the sufficient feedback) of the transferors to meet the technology transfer requirement of the respondents’ organisation. Respondents expressed ‘agreement’ on the appropriate project terms (Table 2, item 2) provided by the business transferors and on the sufficient personal exchange (Table 1, item 5) provided by government. However, the respondents stated ‘neutral’ in regard to the appropriate project terms (Tables 1, 3, and 4, item 2) provided by the government, the university, and the joint program, and the sufficient personal exchange (Tables 2, 3, and 4, item 5) provided by the business, the university, and the joint program. Respondents tended to ‘agree’ with the suitable meeting programs (Table 1 and 4, item 4) provided by the government and the joint program, whereas they expressed ‘neutral’ on the suitable meeting programs (Tables 2 and 3, item 4) offered by the business and the university. Respondents were ‘neutral’ about workshop programs provided by the university (Table 3, item 6), while they expressed ‘agree’ about the benefit of the workshop programs provided by the government, the business, and the joint program (Tables 1, 3, and 4, item 6).

## V. CONCLUSION

This study has summarized an extensive analysis of perceptual responses and survey statements concerning knowledge and technology transfer practices from 250 organisations. The sample of organisations that took part in this survey is plausibly representative of metal-based manufacturing organisations in Java. Overall, the analysis of the responses summarised in this chapter indicate that generally, the participating respondents favourably regard the technology transfer programs offered by government, business and university. However, the response to the other issues related to the technology transfer program including knowledge, adaptation, and technology capability is varied.

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## REFERENCES

- [1] Drucker, P. (1994), “The Age of Social Transformation”, *The Atlantic Monthly*, Vol. 274, No. 5, pp. 53-70.

- [2] Handoko, F, Alan, S, and Burvill, C, 2014. The Role of Government, Universities, and Business in Advancing Technology for SMEs' innovation. *Journal of Chinese Economic and Business Studies*. Vol 12, No. 2. pp. 171
- [3] Handoko, F., Nursanti, E., Harmanto, D and Sutriyono, 2016. The role of tacit and codified knowledge within technology transfer program on technology adaptation. *ARNP Journal of Engineering and Applied Sciences*, Vol.11, No. 8.
- [4] Handoko, F, 2017. Constructing Knowledge and Technology Transfer Model for SMEs Technology Development in Emerging Economies. *International Journal of Pedagogy and Teacher Education*. Vol 1, No. 2. pp. 93
- [5] Handoko, F., Smith, A., Indriani, S. 2017. Technology Transfer for Metal Based SMEs in Central Java Indonesia. *International Journal of Engineering and Management*, [S.l.], v. 1, n. 1, p. 35-41
- [6] Handoko, F., Nursanti, E., Gatot, Tjahjadi, M.E., Hutabarat, J., Mulyadi, L., and Kustamar. 2018. Green Industrial System in Indonesia, *MATEC Web Conf.*, 164 (2018) 01010, DOI: <https://doi.org/10.1051/mateconf/201816401010>
- [7] Tambunan, T. (2005), "Promoting Small and Medium Enterprises with a Clustering Approach: A Policy Experience from Indonesia", *Journal of Small Business Management*, Vol. 43, No. 2, pp.138-154.
- [8] Sandvig, J. C. (2000), "The Role of Technology in Small Firm Diversification", *The Journal of Technology Transfer*, Vol. 25, No.2, pp. 157-168.
- [9] Cavusgil, S.T., Calantone, R.J., and Zhao, Y., 2003; Tacit Knowledge Transfer and Firm Innovation Capability. *Journal of Business and Industrial Marketing*.
- [10] Wijayaningtyas, Ibrahim Sipan, C. W. (2016). Effect of environmental knowledge and concern toward attitude of green home buyers' intention in Surabaya. *Knowledge, Service, Tourism & Hospitality: Proceedings of the Annual International Conference on Management and Technology in Knowledge, Service, Tourism & Hospitality 2015 (SERVE 2015), Bandung, Indonesia, 1-2 August 2015*, 167. Bandung: CRC Press
- [11] Marcotte, C. and Niosi, J. (2000), "Technology Transfer to China The Issues of Knowledge and Learning", *The Journal of Technology Transfer*, Vol. 25, No.1, pp. 43-57.
- [12] Gorman, M. E. (2002), "Types of Knowledge and Their Roles in Technology Transfer", *The Journal of Technology Transfer*, Vol.27, No. 3, pp. 219-231.
- [13] Hidayat, S., Handoko, F., Tjahjadi, M.E., Vitasari, P. 2018, "The Triple Helix and Technology Capability and Competitiveness of SMEs in Developing Economy", *International Journal of Civil Engineering and Technology (IJCET)* 9(13), pp. 366–378.
- [14] Tjahjadi, M.E., Handoko, F., Sai, S.S. (2017), "Novel image mosaicking of UAV's imagery using collinearity condition" *International Journal of Electrical and Computer Engineering*, 7 (3), pp. 1188-1196. DOI: 10.11591/ijece.v7i3.pp1188-1196
- [15] Tjahjadi, M.E., Handoko, F. (2017), "Single frame resection of compact digital cameras for UAV imagery" *4th International Conference on Electrical Engineering, Computer Science and Informatics, EECSI 2017*. DOI: 10.1109/EECSI.2017.8239147.
- [16] Tjahjadi, M.E., Handoko, F. (2017), "Precise wide baseline stereo image matching for compact digital cameras" *4th International Conference on Electrical Engineering, Computer Science and Informatics, EECSI 2017*. DOI: 10.1109/EECSI.2017.8239106.
- [17] Kremic, T. (2003), "Technology Transfer: A Contextual Approach", *The Journal of Technology Transfer*, Vol. 28, No. 2, pp. 149-158.
- [18] Bozeman, B. (2000), "Technology Transfer and Public Policy: A review of research and theory.", *Research Policy*, Vo. 29, pp. 627-655.
- [19] Chen, Edward K.Y 1994. Introduction: Transnational Corporations and Technology Transfer to Developing Countries. Vol.18 the United Nations Library on Transnational Corporations.
- [20] Singh, Prakash J. 2002. A Study of Theoretical and Empirical Bases of Operationalising Popular Quality Management Approaches in Manufacturing Organizations in Australia. PhD Dissertation.
- [21] Porter, M.E., 2008. "Competitive Advantage": Creating and Sustaining Superior Performance. The Free Press. (Revision).
- [22] Flynn, B.B., Schroeder, R.G. and Sakakibara, S. (1994), "A Framework for Quality Management Research and Associated Measurement Instrument", *Journal of Operations Management*, Vol. 11, pp.339-366.
- [23] Hair, J.F., Black, W.C., Babin, B.J. and Anderson, E.R. (2010), "Multivariate Data Analysis", Seventh edition, Person Prentice Hall.
- [24] Matre, J.G.V., and Gilberth, G.H., 1987; *Statistics for Business and Economics*. (3<sup>rd</sup> ed. Plan, Texas: Business Publications.