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The impact of engineers' skills and problem-solving abilities on process innovation

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ABSTRACT
This study examines the relationship among engineers' basic skills, problem-finding and -solving capabilities, and innovation outcomes, using questionnaire survey data for Lao P.D.R., Thailand and Vietnam for the period 2016 to 2017. We perform two-stage least squares (2S.L.S.) estimations, which use the variables for engineers' basic skills and capabilities for finding and solving problems within the firm as instruments, and the indicators for capabilities for finding and solving problems of suppliers and customers as endogenous variables. The estimation results reveal the relationship between problem-finding and -solving capabilities and process innovation. The findings from the empirical analyses suggest a possible upgrading strategy for firms to transform quality control management into innovative abilities. The estimation results also support the necessity of policy support for nurturing both engineers' basic technological and managerial skills and capabilities for problem-finding and -solving.

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1. Introduction

When promoting innovation, increasing the capacity of human resources is a fundamental issue for firms in both the private and public sectors. Firms in developing countries often adopt kaizen (i.e., the Japanese style of continuous improvement activities) to develop the human resources and organisational capabilities necessary for entering into buyer–supplier collaborations (Machikita, Tsuji & Ueki, 2016), which enable firms to access external knowledge and achieve innovation. Kaizen is a necessary, but not sufficient, method for innovation, as practices for continuous improvement implementation are continuously changing (Iwao, 2017; Singh & Singh, 2015).

How does kaizen help firms that attempt to enter into production networks where buyer–supplier collaborations are active? This study assumes that engineers' basic technological and managerial knowledge, which can be developed through continuous improvement activities, are the foundation for building the capabilities to find and solve problems of the firms and those of their buyers and customers (Hasan & Dutta,

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2017; Intarakumnerd, 2017). These capabilities enable buyers and suppliers to collaborate with firms and achieve innovation (Hasan & Hossain, 2018). A few factors that contribute to the success of kaizen include working culture, corporate strategy, kaizen leaders and organisational structure (Habidin, Hashim, Fuzi & Salleh, 2018; Maarof & Mahmud, 2016). The contribution of this study consists in providing the analysis of a new factor that guarantees the successful implementation of kaizen and the resolution of its challenges on the basis of the problem-solving capacities of engineers.

Based on observation, this study examines the relationship between engineers' basic skills, their problem-finding and -solving capabilities, and process innovations as innovation outcomes. Technical knowledge does not automatically generate innovation. This does not automatically imply that technical knowledge allows the transmission to successful process innovations, and an extensive literature on competency and innovation is available to support this (Borras & Edquist, 2015; Bublitz, Fritsch & Wyrwich, 2015; Khoreshok et al., 2016; Tsuji, Shigeno, Ueki, Idota & Bunno, 2017).

This paper presents an empirical examination of the assumed mediating effect of problem-finding and -solving capabilities on the association between engineers' basic skills and process innovations, using the original dataset developed by a questionnaire survey conducted in Lao P.D.R., Thailand and Vietnam in the period 2016 to 2017. This study enters the variables for engineers' basic skills as instruments and the indicators for problem-finding and -solving capabilities as endogenous variables in instrumental variables (I.V.) regression models. The results of the I.V. regressions reveal the relationship between problem-finding and -solving capabilities and innovative activities.

Further, this study includes innovations to the kaizen sustainability phenomenon, as it is, with the basic skills of engineers as instruments and indicators for the identification of problems and the capacity of resolution through innovation instruments that are known in the current literature. The findings from the empirical analysis suggest a possible upgrading strategy for firms to transform quality control management into innovative capabilities. The estimation results also support the necessity of policy support for nurturing both engineers' basic skills and their problem-finding and -solving capabilities. The findings from this study emphasise that governments must provide appropriate support to the development stage of engineers' skills and firms' organisational capabilities. This study derives these unique policy implications from rigorous empirical analysis.

The remainder of this paper is organised in the following manner. Section 2 reviews the literature and develops hypotheses. Section 3 explains the method, including data, variables and models. Section 4 presents the results of regressions. Section 5 concludes this study by discussing the results and managerial and policy implications.

2. Capability and innovation

2.1. Innovation and problem-finding and -solving

Firms need to innovate. A seminal study by Cohen and Levinthal (1990) proposed a concept of a firm's absorptive capacity, defined as the ability to recognise the value of new external information, assimilate it and apply it to commercial ends. Cohen and

Levinthal (1990) also argued that absorptive capacity is a function of the firm's prior knowledge level. This prior knowledge includes problem-solving methods, which create new knowledge and increase absorptive capacity.

Empirical studies indicate these organisational capabilities as being instruments for innovation (Herrmann, Gassmann & Eisert, 2007; Lin, Su & Higgins, 2016; Pisano, 2015; Ruiz-Jiménez & Fuentes-Fuentes, 2016; Yam, Lo, Tang & Lau, 2011). The process of innovation has many different perspectives, and this study includes the concept of 'smart', which seeks to be intelligent, proactive, purposeful and aspirational. A smart society requires new ideas or technologies to provide new possibilities (Lee & Trimi, 2016). On the other hand, one study showed that research and development (R&D) significantly impacts economic growth, and raised the question of whether innovation policy must set common numerical targets (Kacprzyk & Doryń, 2017).

Similarly, according to Andersson, Holm and Johanson (2007), problem-solving promotes the flow of new knowledge through inter-firm networks or creates new knowledge within and between firms. Problem-solving also involves combining existing knowledge. Therefore, problem-solving can lead to technology development (Andersson et al., 2007) and improvement of firms' performance (Giampaoli, Ciambotti & Bontis, 2017). These arguments suggest that problem-solving promotes innovation.

From a perspective of knowledge management, problem-solving can be conceptually separated from problem-finding and recognition. Before a problem can be solved, it must be recognised (Gray, 2001). This distinction suggests that firms must be able to recognise the existence of a problem and take the necessary actions to solve it. By understanding how to find and solve problems, firms are able to learn and innovate. Therefore, the following main hypothesis is proposed in this study.

H. Problem-finding/-solving capabilities in a firm promote innovation.

Problem-solving is not merely about solving problems. Firms create and define problems and then develop and apply new knowledge to solve the problems. Thereafter, firms further develop new knowledge through the action of problem-solving (Nonaka, Toyama & Konno, 2000). Problem-finding and -solving and related abilities create new insights, which are transferred within and among firms (Andersson et al., 2007). A problem can be considered as a source of new knowledge and innovative abilities.

Therefore, it is crucial for firms to secure sources of information on problems that need to be solved, although previous studies focussed mostly on access to new technological knowledge. In practice, a firm can find problems inside the firm and on its customers' and suppliers' sites.

Through its daily operations, the firm may discover a problem internally. The firm also communicates with its customers and suppliers, and occasionally visits its business partners to give advice or learn from experiences in finding and solving problems that cannot be found or solved within the firm (Aoki & Wilhelm, 2017; Sako, 2004). By combining existing knowledge within the firm with new knowledge from its suppliers or customers, firms can discover new ways to solve the problems.

From an industrial marketing perspective, problem-solving is an important means for a firm to obtain information regarding its customers' needs and preferences, enhance customer satisfaction and yield higher profits (Graham, 1986). Innovations are driven not only by technology but by customers as well. Information obtained regarding customer issues can be used by the firm to propose solutions to problems. The process of problem-solving may stimulate innovation by the firm and its customers. Therefore, innovations are relevant for customers who appreciate the costly and uncertain R&D efforts and value those firms that constantly offer innovative solutions (Höflinger, Nagel & Sandner, 2018).

Finding and solving problems faced by a firm's supplier are also important for the firm to develop reliable suppliers. For supplier development, corporate buyers visit their suppliers to identify problems, provide technical assistance and improve suppliers' operations. Corporate buyers can propose solutions or let suppliers find solutions independently. Such buyer–supplier interactions may generate new knowledge for buyers and their suppliers, consequently leading to innovations.

With a background of these discussions and the findings of Day (1994), which differentiate capabilities into those for solving a firm's own problems and its partner's problems, the main hypothesis (H) can be divided into the following sub-hypotheses.

H1. The capacity to find/solve a firm's own problems promotes innovation.

H2. The capacity to find/solve a customer's/supplier's problems promotes innovation.

H2c. The capacity to find/solve a customer's problems promotes innovation.

H2s. The capacity to find/solve a supplier's problems promotes innovation.

2.2. Problem-finding/-solving capabilities and employee skills

If problem-finding and -solving capabilities are relevant to innovations, developing them becomes an important managerial and policy challenge. A study on high-technology small- and medium-sized enterprises (S.M.E.s) indicates the relevance of open innovation practices in supporting growth by improving inventiveness and commercialisation (Pustovrh, Jaklič, Martin & Rašković, 2017).

A widely adopted practice for problem-solving in the manufacturing sector is kaizen and other quality management methods that together comprise total quality management (T.Q.M.). Day (1994) insists that T.Q.M. enables firms engaged in developing employees and organisations to not only have the internal capabilities necessary for continuous improvements but also orientations and capabilities for solving customers' problems.

In Japanese manufacturing, kaizen is fundamental to the development of individual and organisational capabilities for continuous improvement, and has significant impacts on establishing cooperative buyer–supplier relationships and knowledge transfer (Machikita et al., 2016; Sarfraz, Rajendran, Hewege & Mohan, 2018). The main elements of kaizen comprise simple organisational routines, such as 5S (i.e., sort, set, shine, standardise, sustain), quality control circles and other small-group activities implementable without a large amount of capital investment. Kaizen enhances not only workers' technical and technological skills to find and solve problems, but also workplace discipline and organisational culture to promote learning and continuous improvements. Similarly, Kaynak (2003) also argues that effective employee training can transform employees into creative problem-solvers, with training in quality-related issues that emphasise problem-solving in small groups. This type of training enables employees to identify innovative approaches to improve the organisation of their firms.

The importance of employee discipline and commitment to firm goals is also emphasised by family business studies, which show that family firms are more likely than non-family firms to invest in innovation in traditional sectors of the economy. Small business owners who self-identify as family firms tend to have higher employee commitment, and family employees who increase innovation output (Ahluwalia, Mahto & Walsh, 2017).

The improvement of innovative ability is central to producing successful innovations, and a study has shown that innovative ability depends on the employee's creativity and is closely linked to the innovation support organisation's culture (Rajapathirana & Hui, 2018).

Although policy-makers in developing countries tend to use kaizen and employee training to develop and improve worker skills, the Toyota Production System (T.P.S.) requires the fostering of a culture of discipline and establishing mindsets and routines for finding and creatively solving problems (Khazanchi, Lewis & Boyer, 2007).

Research has demonstrated that high-performance work systems (H.P.W.S.) enhance organisational performance and innovation in start-ups (Bendickson, Muldoon, Liguori & Midgett, 2017). The use of H.P.W.S. can impact the performance of small firms via intellectual capital development in firms (Coder, Peake & Spiller, 2017).

Another overlooked aspect of the T.P.S. is its function for developing managers who are skilled in coaching and teaching workers engaged in kaizen and problem-solving. Jishukens (i.e., autonomous study groups) in the T.P.S. enable managers to not only solve their own problems but also to improve the communication, coaching and teaching skills of managers (Marksberry, Badurdeen, Gregory & Kreafle, 2010). Enhanced managerial skills facilitate internal and external knowledge sharing and therefore enhance their subordinates' problem-solving capabilities (Carmeli, Gelbard & Reiter-Palmon, 2013). Therefore, managerial skills also affect problem-finding/-solving capabilities.

If we differentiate problems into internal, customers' and suppliers' problems, then we can derive the following hypotheses.

H3. The skills of a firm's engineers, including technological and managerial skills, affect the capability for finding/solving the firm's own problems.

H4. The skills of a firm's engineers, including technological and managerial skills, affect the capability for finding/solving a customer's/supplier's problems.

H4c. The skills of a firm's engineers, including technological and managerial skills, affect the capability for finding/solving a customer's problems.

H4s. The skills of a firm's engineers, including technological and managerial skills, affect the capability for finding/solving a supplier's problems.

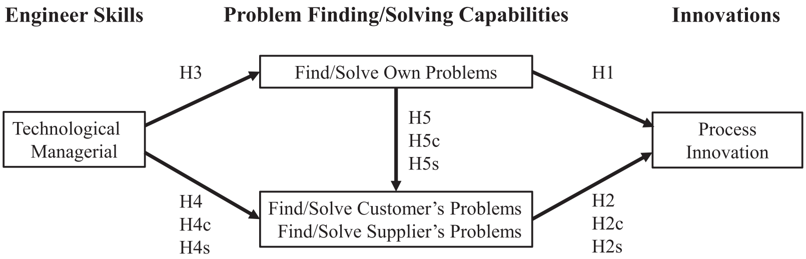

Figure 1. Conceptual framework.
Source: authors.

Activities for building technological and managerial skills nurture managers and employees who are encouraged to make continuous improvement and who value learning, quality, cost and customer satisfaction. According to Goh (2002), a problem-seeking and problem-solving culture facilitates knowledge sharing and knowledge transfer. It is not, however, easy for firms to share knowledge across organisations, in particular tacit knowledge beyond the firm's boundaries (Dhanaraj, Lyles, Steensma & Tihanyi, 2004). Machikita et al. (2016) explained that a firm that can share knowledge across departments within the firm can also share knowledge with its supplier(s). Therefore, it is expected that firms that can utilise internal information to find and solve their own problems can access external information that is useful for finding and solving their customers' and suppliers' problems, consequently enhancing its ability to find and solve these problems (see Figure 1).

H5. The capability of finding/solving one's own problems affects the capability of finding/solving a customer's/supplier's problems.

H5c. The capability of finding/solving one's own problems affects the capability of finding/solving a customer's problems.

H5s. The capability of finding/solving one's own problems affects the capability of finding/solving a supplier's problems.

3. Method

3.1. Survey data

This study uses survey data constructed in cooperation with research institutes in Lao P.D.R., Thailand and Vietnam. The survey targeted manufacturing industries, which consist of both locally owned and foreign-owned establishments of all sizes. The authors developed a questionnaire in English, which was translated into local languages and distributed to firms. Responses were collected via local research institutes from December 2016 to March 2017.

The selected survey sites were major industrial districts in each country. The survey in Lao P.D.R. mainly targeted establishments in the Vientiane municipality and Champasak and Savannakhet provinces, where the Government of Lao P.D.R. develops special economic zones (S.E.Z.s) to develop manufacturing industries. The survey in Thailand was focussed mainly on Bangkok and neighbouring provinces. The

Table 1. Definitions and summary statistics for the variables used.

Variable	Description	Mean	SD	Min	Max
	Process innovation (four-point Likert scale)				
pi1	Reduced defects during a manufacturing process	1.769	0.862	0	3
pi2	Reduced labour input (man-hour)	1.415	0.899	0	3
pi3	Reduced lead time to introduce a new product	1.387	0.915	0	3
pi4	Reduced unscheduled line stop	1.483	0.965	0	3
pi5	Reduced workers' injuries	1.718	1.038	0	3
pi6	Reduced plant accidents	1.741	1.059	0	3
pi7	Reduced delivery delay	1.908	0.959	0	3
pi8	Reduced dispersion in product quality	1.842	0.919	0	3
pi9	Reduced time to changeover	1.579	0.962	0	3
pi10	Reduced claims from customers	1.874	0.892	0	3
pi11	Reduced plant maintenance costs	1.509	0.867	0	3
pi	Process improvement	0.000	2.297	−5.855	4.708
	Skill/capability level (five-point Likert scale)				
capt	Technological skill	2.731	0.780	0	4
capm	Management skill	2.726	0.759	0	4
capf	Capabilities to find own problems	2.669	0.766	0	4
caps	Capabilities to solve own problems	2.697	0.730	0	4
capf_c	Capabilities to find customers' problems	2.628	0.757	0	4
caps_c	Capabilities to solve customers' problems	2.635	0.750	0	4
capf_s	Capabilities to find suppliers' problems	2.581	0.752	0	4
caps_s	Capabilities to solve suppliers' problems	2.571	0.764	0	4
capfs_cs	Capabilities to find/solve customers'/suppliers' problems	0.000	1.799	−6.890	3.696
	Control variables				
asset	Total assets (ordinal)	7.126	2.154	1	10
r&d	R&D expenditure as a percentage of sales (ordinal)	0.880	1.055	0	3
local	100% locally owned (dummy)	0.688	0.464	0	1
lao	Laos (dummy)	0.359	0.480	0	1
tha	Thailand (dummy)	0.312	0.464	0	1
vnm	Vietnam (dummy)	0.329	0.470	0	1

Note: Number of observations = 486. Process innovation (four-point Likert scale: 0 = none; 1 = little; 2 = somewhat; 3 = much). Skill/capability level (five-point Likert scale: 0 = very unsatisfactory; 1 = unsatisfactory; 2 = neither; 3 = satisfactory; 4 = very satisfactory). Total assets (ordinal: 1 = Less than USD 10,000; 2 = USD 10,000–24,999; 3 = USD 25,000–49,999; 4 = USD 50,000–74,999; 5 = USD 75,000–99,999; 6 = USD 100,000–499,999; 7 = USD 500,000–999,999; 8 = USD 1 million–4.9 million; 9 = USD 5 million–9.9 million; 10 = USD 10 million or more). R&D expenditure/sales (ordinal: 0 = no expenditure; 1 = less than 0.5%; 2 = 0.5–0.99%; 3 = 1% or more).
Source: authors.

survey in Vietnam focussed on establishments in the greater Hanoi and greater Ho Chi Minh City regions.

To distribute and collect the questionnaire, each local study team used appropriate methods, such as email and face-to-face contact, to collect more valid responses. The Lao P.D.R. study team distributed 290 questionnaires and collected 170 responses (i.e., 58.6% response rate). The Thai study team distributed 1000 questionnaires and collected 209 responses (i.e., 20.9% response rate). The Vietnamese study team selected 1000 establishments in the two metropolitan regions and collected 154 valid responses (i.e., 15.4% response rate), which comprised 82 responses from the greater Hanoi region and 72 from the greater Ho Chi Min City region.

Consequently, the research developed the dataset with a total of 533 observations. After excluding the respondents who did not answer the questions used for this study, 486 observations were available for statistical analysis. The observations for Lao P.D.R., Thailand and Vietnam comprised 35.9%, 31.2% and 32.9% of the 486 observations, respectively (Table 1).

This study uses the aggregate data from these three countries to achieve the objectives of examining the effects of engineers' basic skills on process improvements. Because the development of human resources, engineering skills and innovation capabilities is a challenge common to all developing countries and industries, this study prioritises the identification of a path leading from engineers' skills to process innovations over characterising national and sectoral innovation systems.

3.2. Measurement

3.2.1. Engineers' skills and capabilities

This study focuses on examining the relationship between problem-finding/-solving capabilities and innovation. In addition, to gain a deeper understanding of the capacity development process, this study investigates the association between engineers' skills and problem-finding/-solving capabilities.

To measure engineers' capabilities, the questionnaire asked about respondents' satisfaction with their engineers' capabilities. The respondents assessed satisfaction levels on a five-point Likert scale (i.e., $0 =$ very unsatisfactory, $1 =$ unsatisfactory, $2 =$ neither, $3 =$ satisfactory, $4 =$ very satisfactory). Further, the survey broadly categorised capabilities into engineers' skills and problem-finding/-solving capabilities. Problem-finding/-solving capabilities of the respondents' engineers and their association with innovations are the main interests of this study. The problem-finding/-solving capabilities in this survey comprises six types of capabilities (see Table 1): (1) discovering internal problems (the variable *capf*); (2) solving own problems (*caps*); (3) finding customers' problems (*capf_c*); (4) solving customers' problems (*caps_c*); (5) finding supplier problems (*capf_s*); and (6) solving supplier problems (*caps_s*).

In addition to these measurements for individual capability, a composite indicator for problem-finding/-solving customer and/or supplier problems (*capfs_cs*) was constructed from the four variables for capabilities to find/solve customer and/or supplier problems using principal component analysis (P.C.A.), which is widely used for measuring factors related to innovations and firm performances such as human resources (Blanco-Mazagatos, de Quevedo-Puente & Delgado-García, 2018; Del Valle & Castillo, 2009; Gooderham, Parry & Ringdal, 2008) and absorptive capacity (Caragliu & Nijkamp, 2012; Escribano, Fosfuri & Tribó, 2009; Glas, Hübler & Nunnenkamp, 2016). Before performing P.C.A., Cronbach's alpha was computed, which equalled 0.92. The calculated eigenvalue and proportion for the first principal component were 3.24 and 0.81, respectively. This first principal component is defined as the composite indicator for capabilities to find and solve customer and supplier problems (*capfs_cs*).

Engineering skill was classified as either technological (the variable *capt* in Table 1) or managerial (*capm*). Technological skills referred to technological expertise, whereas managerial skills included management ability, leadership and coaching skill. In addition, human skill (e.g., communication skill, self-motivation) was also listed as an engineering skill. The survey included questions regarding the satisfaction levels for these three types of skills on a five-point Likert scale, with the assumption that these skills are fundamental for firms to develop problem-finding/-solving capabilities.

The measurements for human skill did not, however, show a significant relationship with finding/solving capabilities, and was excluded from the regression analyses.

3.2.2. Product innovation

The survey contained questions on product and process innovation. Previous related studies on problem-solving (Khazanchi et al., 2007) focussed on process innovation, and this study also examines the association between problem-finding/solving capabilities and process innovation.

The survey asked respondents the extent to which processes improved during the period of 2015 to 2016 on a four-point Likert scale (i.e., 0 = none, 1 = little, 2 = somewhat, 3 = much). Process improvements in this survey were measured with the reduction of: (1) defects during a manufacturing process; (2) labour input; (3) lead time to introduce new products; (4) unscheduled line stops; (5) worker injuries; (6) plant accidents; (7) delivery delays; (8) dispersion in product quality; (9) time to changeover (converting production lines); (10) claims from customers; and (11) plant maintenance costs. These measurements for process innovation were summarised into a composite indicator (*pi*) by calculating the first principal component with P.C.A. (Cronbach's alpha = 0.89, eigenvalue = 5.28, proportion = 0.48) for the empirical analyses performed in this paper.

Further, this study does not focus on the relationship of problem-finding/-solving capability with a specific type of process innovation, but examines whether the capability of finding/solving problems in a firm, its customers and suppliers generates different associations with process innovation. Therefore, we develop a composite indicator for process innovation.

3.2.3. Control variables

The survey collected data on characteristics of the respondent establishments. The regression analyses performed in this study used this data for control variables. The variable for total assets was introduced in the regression analyses to remove the effect of establishment size on the composite process improvement indicator. This variable is ordinal and codified in Table 2.

R&D expenditure as a percentage of sales is also an ordinal variable codified as 0 if the respondent made no expenditure, 1 if the ratio was less than 0.5%, 2 if it was 0.5–0.99% and 3 if it was 1% or more.

Table 2. Variable for total assets.

Value	Size
1	Less than USD 10,000
2	USD 10,000–24,999
3	USD 25,000–49,999
4	USD 50,000–74,999
5	USD 75,000–99,999
6	USD 100,000–499,999
7	USD 500,000–999,999
8	USD 1,000,000–4.9,000,000
9	USD 5,000,000–9,900,000
10	USD 10,000,000 or more

Source: authors.

The dummy variable for local establishment was coded as 1 if the respondent establishment was 100% locally owned and 0 otherwise. The dummy for country was defined according to the country surveyed.

Table 1 summarises the variables and descriptive statistics.

3.3. Model

To examine the main hypothesis, which is the association between problem-finding/-solving capabilities and innovations (i.e., H), this study developed two regression models. The first model is a single equation that regresses innovation outcomes on engineers' capabilities

$$pi_{\mathrm{i}} = \alpha + \beta_1 \times cap_{\mathrm{i}} + \beta_2 \times x_{\mathrm{i}} + u_{\mathrm{i}} \tag{1}$$

where pi_{i}, cap_{i}, x_{i} and u_{i} are the composite indicators for process innovation, a measurement for problem-finding/-solving capabilities, a set of the control variables and residual for the respondent *i*, respectively. Ordinary least squares (O.L.S.) estimations were performed to obtain baseline results of testing the first and second hypotheses (i.e., H1, H2, H2c and H2s).

The model shown above presumes that problem-finding/-solving capabilities may be a cause of process innovation. In other words, problem-finding/-solving capabilities and process innovation will not be jointly determined. It may, however, be reasonable to expect the opposite causality from the presumption. This problem, as well as the presence of omitted variables and measurement error, is known as endogeneity. When endogeneity exists, O.L.S. yields inconsistent and biased estimates (Wooldridge, 2005, 2010).

To identify and solve the problem of endogeneity, this study performed a second regression model, using a two-stage least squares (2S.L.S.). In contrast to the first O.L.S. estimations, the 2S.L.S. model comprises two equations and uses technological skills and managerial skills as instrumental variables (I.V.s). The first-stage estimation regresses a measurement for problem-finding/-solving capabilities (*cap*) on the variables for technological (*capt*) and managerial (*capm*) skills. The second-stage equation is the same as the model presented above

$$cap_{\mathrm{i}} = \alpha_1 + \beta_{11} \times capt_{\mathrm{i}} + \beta_{12} \times capm_{\mathrm{i}} + \beta_{13} \times x_{\mathrm{i}} + u_{1\imath} \tag{2}$$

$$pi_{\mathrm{i}} = \alpha_2 + \beta_{21} \times cap_{\mathrm{i}} + \beta_{22} \times x_{\mathrm{i}} + u_{2\mathrm{i}}. \tag{3}$$

By introducing a different variable for capabilities for finding/solving own problems (i.e., *capf*, *caps*) into Equation (2) as a dependent variable, this 2S.L.S. model can examine the first and third hypotheses (i.e., H1 and H3). Post-estimation tests will be conducted to test whether the variables for technological (*capt*) and managerial (*capm*) skills can be treated as endogenous.

Equation (2) can be modified by introducing one of the variables for capabilities for finding/solving customers'/suppliers' problems (i.e., *capf_c*, *caps_c*, *capf_s*, *caps_s* and *capf_cs*) into Equation (2) as a dependent variable and add capabilities for finding/solving one's own problems (i.e., *capf*, *caps*) as independent variables; the 2S.L.S. model can then examine the second, fourth and fifth hypotheses (i.e., H2, H2c, H2s, H4, H4c, H4s, H5c and H5s)

$$cap_{\mathrm{i}} = \alpha_1 + \beta_{11} \times capt_{\mathrm{i}} + \beta_{12} \times capm_{\mathrm{i}} + \beta_{13} \times capf_{\mathrm{i}} + \beta_{14} \times caps_{\mathrm{i}} + \beta_{15} \times x_{\mathrm{i}} + u_{1_i} \tag{4}$$

Post-estimation tests were performed to examine whether the variables for capabilities for finding/solving own problems can be treated as endogenous and used as I.V.s to estimate Equations (3) and (4) with 2S.L.S. estimation.

4. Regression results

This section presents results of the O.L.S. and 2S.L.S. estimations. Stata 13.1 (StataCorp. 2013) is used to estimate the regression models.

4.1. O.L.S. regression

Table 3 presents the results of the first regression model using O.L.S. estimations. The model entered eight variables one-by-one for problem-finding/-solving capabilities to avoid multicollinearity that may be caused by correlations among these variables. As described above, the model introduces variables for characteristics of the respondent establishments such as total assets, R&D expenditure as a percentage of sales and country dummies as control variables.

Columns 1 and 2 depict the significant relationship of process innovation with capabilities to find and solve own problems at the 5% level, respectively. Thus, hypothesis H1 is supported. Columns 5 and 6 present the significant relationship of process innovation with capabilities to find and solve suppliers' problems at the 10% and 5% levels, respectively. These results support hypothesis H2s. On the other hand, Columns 3 and 4 present no significant relationship between process innovation and capabilities to find and solve customers' problems. Therefore, H2c is not supported. Column 7 presents the significant relationship of process innovation with the composite indicator for capabilities to find and solve customers' and suppliers' problems at the 10% level. Therefore, H2 is supported.

4.2. 2S.L.S. regression

Table 4 presents the results of 2S.L.S. estimations. Panels 1 and 2 of Table 4 present the results of the first- and second-stage regressions, respectively. After performing 2S.L.S. estimations, we performed the necessary procedures for post-estimation tests (StataCorp, 2013; Wooldridge, 2010). Panel 3 of Table 4 presents the results of the post-estimation tests, including the Durbin test of endogeneity, *F*-statistic for weak instrument and the Sagan test of overidentifying restrictions. The estimation presented in column 1 of Table 4 introduces the variables for engineers' technological skill and management skill as instrumental variables. Column 1 in panel 1 presents significant relationships of technological and management skills with capabilities to

Table 3. O.L.S. regression of process innovation on problem finding/solving capabilities.

Variable	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Independent variable							
capf: Capabilities to find own problems	0.335**						
	(0.143)						
caps: Capabilities to solve own problems		0.329**					
		(0.148)					
capf_c: Capabilities to find customers' problems			0.180				
			(0.150)				
caps_c: Capabilities to solve customers' problems				0.164			
				(0.146)			
capf_s: Capabilities to find suppliers' problems					0.264*		
					(0.146)		
caps_s: Capabilities to solve suppliers' problems						0.319**	
						(0.143)	
capfs_cs: Capabilities index for finding/solving customers'/suppliers' problems							0.113*
							(0.062)
Control variable							
Assets	Yes	Yes	Yes	Yes	Yes	Yes	Yes
R&D expenditure/sales	Yes	Yes	Yes	Yes	Yes	Yes	Yes
100% locally owned firm (dummy)	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Country (dummies)	Yes	Yes	Yes	Yes	Yes	Yes	Yes
F-stat	7.253	7.154	6.517	6.485	6.846	7.159	6.848
R^2	0.086	0.085	0.078	0.078	0.082	0.085	0.082
Adj. R^2	0.074	0.073	0.066	0.066	0.070	0.073	0.070
Observations	468	468	468	468	468	468	468

Note: Standard errors in parentheses. ***$p < 0.01$, **$p < 0.05$, *$p < 0.1$.
Source: authors.

identify own problems at the 5% and 1% levels. These significant coefficients support hypothesis H3. Further, Column 1 in panel 2 presents significant relationships of process innovation with capabilities to identify own problems at the 5% and 1% levels. Therefore, hypothesis H1 is supported. The Durbin test does not, however, reject the null hypothesis that the variable for capabilities to find own problems is exogenous. Column 2 provides a similar result to column 1. The estimated coefficients in panels 1 and 2 are significant, which support hypotheses H3 and H1, respectively. The Durbin test is not, however, significant.

The models in columns 3 to 7 of Table 4 enter the variables for capabilities to find and solve own problems, in addition to engineers' technological skill and management skill as instrumental variables and the indicators for capabilities to find/solve customers'/suppliers' problems as endogenous variables. Columns 3 to 7 in panel 1 show that all the estimated coefficients on the instrumental variables are significant at the 1% or 5% levels. Columns 3 to 7 in panel 2 present significant relationships of process innovation with capabilities to find/solve customers'/suppliers' problems at the 1% level. In contrast to the results of O.L.S., the coefficients on capabilities to find/solve customers' problems are significant at the 1% level.

The results in columns 3 and 4 indicate that hypotheses H4c, H5c (panel 1) and H2c (panel 2) are supported. Hypotheses H4s, H5s and H2s are supported by the results presented in columns 5 and 6. H4, H5 and H2 are also verified by the estimation in column 7.

The post-estimation tests in Panel 3 for the models in column 3 show that the Durbin test of endogeneity is rejected at the 1% level. The *F*-statistic for weak instrument is rejected, thereby implying that the instruments are not weak. Further, the Sagan test of overidentifying restrictions is not rejected, which indicates that the instruments are not invalid or that the model is not incorrectly specified. The estimation of the 2S.L.S. models in column 4 also provides the results of the post-estimation tests, which support the application of 2S.L.S. to the model. Therefore, in contrast to the O.L.S. results, the 2S.L.S. regressions derive significant relationships of process innovation with capabilities to find and solve customers' problems.

Column 5 in panel 3 also shows that the 2S.L.S. estimation is applicable to the model that treats the variables for capabilities to find suppliers' problems as endogenous. The Durbin test of endogeneity is rejected at the 5% level. On the other hand, the Durbin test of endogeneity for the model with the variables for capabilities to solve suppliers' problems (column 6) is not rejected at the 5% level but rejected at the 10% level. Column 7 in panel 3 shows, however, that the 2S.L.S. model is specified correctly when the regression model has the composite indicator capabilities to find and solve customers' and suppliers' problems as the endogenous variable.

These results of 2S.L.S. estimations presented in Table 4 indicate that capabilities to find and solve own, customers' and suppliers' problems are significantly associated with process innovation. The capabilities to find/solve own problems can be exogenous, however, and used as instrumental variables for 2S.L.S. to solve the problem of endogeneity.

5. Conclusions

Problem-solving and learning capabilities are closely associated with innovations. Although these capabilities have similarities, problem-solving capabilities enable the

Table 4. 2S.L.S. regression of process innovation on problem finding/solving capabilities.

Stage	Variable	(1)	(2)	(3)	(4)	(5)	(6)	(7)
First stage. Dependent variable: endogenous variable		*capf*	*caps*	*capf_c*	*caps_c*	*capf_s*	*caps_s*	*capfs_cs*
Instrumental variable								
	capt: Technological skill	0.104**	0.137***	0.203***	0.167***	0.142***	0.178***	0.455***
		(0.044)	(0.042)	(0.038)	(0.038)	(0.040)	(0.041)	(0.080)
	capm: Management skill	0.481***	0.464***	0.091**	0.144***	0.161***	0.152***	0.364***
		(0.046)	(0.043)	(0.045)	(0.044)	(0.048)	(0.049)	(0.095)
	capf: Capabilities to find own problems			0.249***	0.104**	0.260***	0.154***	0.507***
				(0.045)	(0.045)	(0.048)	(0.049)	(0.096)
	caps: Capabilities to solve own problems			0.265***	0.428***	0.216***	0.315***	0.811***
				(0.047)	(0.047)	(0.051)	(0.052)	(0.101)
Second stage. Dependent variable: process innovation								
Independent/endogenous variable								
	capf: Capabilities to find own problems	0.586**						
		(0.249)						
	caps: Capabilities to solve own problems		0.584**					
			(0.245)					
	capf_c: Capabilities to find customers' problems			0.593***				
				(0.216)				
	caps_c: Capabilities to solve customers' problems				0.542***			
					(0.204)			
	capf_s: Capabilities to find suppliers' problems					0.611***		
						(0.222)		
	caps_s: Capabilities to solve suppliers' problems						0.590***	
							(0.216)	
	capfs_cs: Capabilities index for finding/solving customers'/suppliers' problems							0.222***
								(0.081)

(*continued*)

Table 4. Continued.

Stage	Variable	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Control variable for the first and second equations								
	Assets	Yes	Yes	Yes	Yes	Yes	Yes	Yes
	R&D expenditure/sales	Yes	Yes	Yes	Yes	Yes	Yes	Yes
	100% locally owned firm (dummy)	Yes	Yes	Yes	Yes	Yes	Yes	Yes
	Country (dummies)	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Post-estimation test								
	Durbin χ^2	1.507	1.692	7.183	7.172	4.343	2.814	4.453
	Durbin *p*-value	0.220	0.193	0.007	0.007	0.037	0.093	0.035
	I.V. *F*-stat	110.937	128.773	106.524	120.341	87.167	88.423	163.996
	Sargan χ^2	0.469	0.326	0.086	0.558	0.121	0.256	0.202
	Sargan *p*-value	0.494	0.568	0.993	0.906	0.989	0.968	0.977
	Wald	43.846	43.946	45.151	44.746	45.487	45.723	45.659
	Observations	468	468	468	468	468	468	468

Note: Standard errors in parentheses. $^{***}p < 0.01$, $^{**}p < 0.05$, $^{*}p < 0.1$.
Source: authors.

creation of new knowledge (Cohen & Levinthal, 1990). Thus, this study conducts in-depth investigations on problem-solving capabilities.

This study broadly categorised capabilities into engineers' technological and management skills and problem-finding and -solving capabilities. The capabilities were divided according to the following two classification bases: capabilities to: (1) solve; or (2) find own, customers' and suppliers' problems. O.L.S. and 2S.L.S. estimations were applied to investigate the relationships between process innovation and problem-finding/-solving capabilities.

The regression analyses revealed that the capabilities for finding and solving own problems have positive relationships with engineers' technological and management skills. Basic technological and managerial skills of engineers are fundamental to building capacities to find and solve own problems for firms, which will result in promoting process innovations. These findings are consistent with the previous studies on kaizen and T.Q.M., such as Marksberry et al. (2010), that focus on solving problems within the firms.

The estimation results of the first and second 2S.L.S. regression models in Table 4 also showed that both capabilities for finding and solving own problems are exogenous. We used this finding for the 2S.L.S. regression analyses on the association between process innovation and capabilities for finding and solving customers' problems and suppliers' problems that are both endogenous.

The results of the 2S.L.S. regressions indicated that enhancing engineers' skills and capacities to find and solve own problems can also result in capacity building for finding and solving suppliers' and customers' problems. All these skill and capacity enhancements may consequently promote process innovation. This finding corresponds to that of Day (1994) and Machikita et al. (2016), claiming that relationships with customers will contribute to improving firms' performances. These studies did not, however, empirically investigate the effects of capabilities for finding and solving problems of customers and suppliers on firms' performances.

A managerial and policy implication from these findings is the importance of promoting kaizen activities to develop engineers' management skills (e.g., management ability, leadership and coaching skills) in addition to technological skills, to have a better understanding of customers and suppliers and achieve process improvements. This implication should be emphasised, particularly in developing countries, where policy debates on engineers' capacity building, vocational training and innovation promotion tend to be focussed on technological aspects within firms.

This study highlights only a few of the complex mechanisms that enable firms in developing countries to innovate. Although this aspect is a limitation of this study, the findings from the empirical analysis suggest a possible upgrading strategy for firms to transform quality control management into innovative capabilities. The estimation results also support the necessity of policy support for nurturing both engineers' basic skills, and problem-finding and -solving capabilities.

Further, what the findings from this study emphasise is that governments must provide appropriate support to the development of engineers' skills and firms' organisational capabilities necessary for collaborating with suppliers and customers to find and solve own and partners' problems. This study derives these policy implications from rigorous empirical analysis.

The limitations of this study include a lack of international comparison due to the small sample size of individual country data, even though the dataset comprises data from three countries. In practice, it is not easy to develop datasets that allow a rigorous international comparison among these countries because of different industrial structures, difficulties in collecting responses from firms in specific industries and low response rates. We could develop models to examine factors that promote product innovations. In contrast with process innovations that can be closely related to kaizen activities and problem-solving, we assume that further investigations will be needed for taking more factors into consideration to develop a similar model for product innovations. These are issues that must be addressed in a future study.

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References

Ahluwalia, S., Mahto, R. V., & Walsh, S. T. (2017). Innovation in small firms: Does family vs. non-family matter? *Journal of Small Business Strategy*, *27*(3), 39–49.

Andersson, U., Holm, D. B., & Johanson, M. (2007). Moving or doing? Knowledge flow, problem solving, and change in industrial networks. *Journal of Business Research*, *60*(1), 32–40. doi:10.1016/j.jbusres.2006.09.010

Aoki, K., & Wilhelm, M. (2017). The role of ambidexterity in managing buyer–supplier relationships: The Toyota case. *Organization Science*, *28*(6), 1080–1097. doi:10.1287/orsc.2017.1156

Bendickson, J. S., Muldoon, J., Liguori, E. W., & Midgett, C. (2017). High performance work systems: A necessity for start-ups. *Journal of Small Business Strategy*, *27*(2), 1–12.

Blanco-Mazagatos, V., de Quevedo-Puente, E., & Delgado-García, J. B. (2018). Human resource practices and organizational human capital in the family firm: The effect of generational stage. *Journal of Business Research*, *84*, 337–348. doi:10.1016/j.jbusres.2017.09.017

Borras, S., & Edquist, C. (2015). Education, training and skills in innovation policy. *Science and Public Policy*, *42*(2), 215–227. doi:10.1093/scipol/scu043

Bublitz, E., Fritsch, M., & Wyrwich, M. (2015). Balanced skills and the city: An analysis of the relationship between entrepreneurial skill balance, thickness, and innovation. *Economic Geography*, *91*(4), 475–508. doi:10.1111/ecge.12097

Caragliu, A., & Nijkamp, P. (2012). The impact of regional absorptive capacity on spatial knowledge spillovers: The Cohen and Levinthal model revisited. *Applied Economics*, *44*(11), 1363–1374. doi:10.1080/00036846.2010.539549

Carmeli, A., Gelbard, R., & Reiter-Palmon, R. (2013). Leadership, creative problem-solving capacity, and creative performance: The importance of knowledge sharing. *Human Resource Management*, *52*(1), 95–121. doi:10.1002/hrm.21514

Coder, L., Peake, W. O., & Spiller, M. S. (2017). Do high performance work systems pay for small firms? An intellectual capital building perspective. *Journal of Small Business Strategy*, *27*(2), 13–35.

Cohen, W. M., & Levinthal, D. A. (1990). Absorptive capacity: A new perspective on learning and innovation. *Administrative Science Quarterly*, *35*(1), 128–152. doi:10.2307/2393553

Day, G. S. (1994). The capabilities of market-driven organizations. *Journal of Marketing*, *58*(4), 37–52. doi:10.1177/002224299405800404

Del Valle, I. D., & Castillo, M. A. S. (2009). Human capital and sustainable competitive advantage: An analysis of the relationship between training and performance. *International Entrepreneurship and Management Journal*, *5*(2), 139–163.

Dhanaraj, C., Lyles, M. A., Steensma, H. K., & Tihanyi, L. (2004). Managing tacit and explicit knowledge transfer in IJVs: The role of relational embeddedness and the impact on performance. *Journal of International Business Studies*, *35*(5), 428–442. doi:10.1057/palgrave.jibs.8400098

Escribano, A., Fosfuri, A., & Tribó, J. A. (2009). Managing external knowledge flows: The moderating role of absorptive capacity. *Research Policy*, *38*(1), 96–105. doi:10.1016/j.respol.2008.10.022

Giampaoli, D., Ciambotti, M., & Bontis, N. (2017). Knowledge management, problem solving and performance in top Italian firms. *Journal of Knowledge Management*, *21*(2), 355–375. doi:10.1108/JKM-03-2016-0113

Glas, A., Hübler, M., & Nunnenkamp, P. (2016). Catching up of emerging economies: The role of capital goods imports, FDI inflows, domestic investment and absorptive capacity. *Applied Economics Letters*, *23*(2), 117–120. doi:10.1080/13504851.2015.1054065

Goh, S. C. (2002). Managing effective knowledge transfer: An integrative framework and some practice implications. *Journal of Knowledge Management*, *6*(1), 23–30. doi:10.1108/13673270210417664

Gooderham, P., Parry, E., & Ringdal, K. (2008). The impact of bundles of strategic human resource management practices on the performance of European firms. *The International Journal of Human Resource Management*, *19*(11), 2041–2056. doi:10.1080/09585190802404296

Graham, J. L. (1986). The problem-solving approach to negotiations in industrial marketing. *Journal of Business Research*, *14*(6), 549–566. doi:10.1016/0148-2963(86)90014-7

Gray, P. H. (2001). A problem-solving perspective on knowledge management practices. *Decision Support Systems*, *31*(1), 87–102. doi:10.1016/S0167-9236(00)00121-4

Habidin, N. F., Hashim, S., Fuzi, N. M., & Salleh, M. I. (2018). Total productive maintenance, kaizen event, and performance. *International Journal of Quality & Reliability Management*, *35*(9), 1853–1867. doi:10.1108/IJQRM-11-2017-0234

Hasan, M. Z., & Dutta, A. (2017). Personal skill development by applying 'KAIZEN': An experimental case study. *Asian Journal of Mathematical Sciences (AJMS)*, *1*(06), 234–240.

Hasan, Z., & Hossain, M. S. (2018). Improvement of effectiveness by applying PDCA cycle or Kaizen: An experimental study on engineering students. *Journal of Scientific Research*, *10*(2), 159–173. doi:10.3329/jsr.v10i2.35638

Herrmann, A., Gassmann, O., & Eisert, U. (2007). An empirical study of the antecedents for radical product innovations and capabilities for transformation. *Journal of Engineering and Technology Management*, *24*(1–2), 92–120. doi:10.1016/j.jengtecman.2007.01.006

Höflinger, P. J., Nagel, C., & Sandner, P. (2018). Reputation for technological innovation: Does it actually cohere with innovative activity? *Journal of Innovation & Knowledge*, *3*(1), 26–39. doi:10.1016/j.jik.2017.08.002

Intarakumnerd, P. (2017). Human resource management and coordination for innovative activities in production networks in Asia: A synthesis. *Asian Journal of Technology Innovation*, *25*(2), 199–205. doi:10.1080/19761597.2017.1385957

Iwao, S. (2017). Revisiting the existing notion of continuous improvement (Kaizen): Literature review and field research of Toyota from a perspective of innovation. *Evolutionary and Institutional Economics Review*, *14*(1), 29–59. doi:10.1007/s40844-017-0067-4

Kacprzyk, A., & Doryń, W. (2017). Innovation and economic growth in old and new member states of the European Union. *Economic Research-Ekonomska Istraživanja*, *30*(1), 1724–1742. doi:10.1080/1331677X.2017.1383176

Kaynak, H. (2003). The relationship between total quality management practices and their effects on firm performance. *Journal of Operations Management*, *21*(4), 405–435. doi:10.1016/S0272-6963(03)00004-4

Khazanchi, S., Lewis, M. W., & Boyer, K. K. (2007). Innovation-supportive culture: The impact of organizational values on process innovation. *Journal of Operations Management*, *25*(4), 871–884. doi:10.1016/j.jom.2006.08.003

Khoreshok, A. A., Zhironkin, S. A., Tyulenev, M. A., Barysheva, G. A., Blumenstein, V. Y., Hellmer, M. C., & Potyagailov, S. V. (2016). Innovative technics of managing engineers' global competencies. *IOP Conference Series: Materials Science and Engineering*, *142*(1), 012122. doi:10.1088/1757-899X/142/1/012122

Lee, S. M., & Trimi, S. (2016). Innovation for creating a smart future. *Journal of Innovation & Knowledge*, *3*(1), 1–8. doi:10.1016/j.jik.2016.11.001

Lin, H. F., Su, J. Q., & Higgins, A. (2016). How dynamic capabilities affect adoption of management innovations. *Journal of Business Research*, *69*(2), 862–876.

Maarof, M. G., & Mahmud, F. (2016). A review of contributing factors and challenges in implementing Kaizen in small and medium enterprises. *Procedia Economics and Finance*, *35*, 522–531. doi:10.1016/S2212-5671(16)00065-4

Machikita, T., Tsuji, M., & Ueki, Y. (2016). Does Kaizen create backward knowledge transfer to Southeast Asian firms? *Journal of Business Research*, *69*(5), 1556–1561. doi:10.1016/j.jbusres.2015.10.016

Marksberry, P., Badurdeen, F., Gregory, B., & Kreafle, K. (2010). Management directed Kaizen: Toyota's Jishuken process for management development. *Journal of Manufacturing Technology Management*, *21*(6), 670–686. doi:10.1108/17410381011063987

Nonaka, I., Toyama, R., & Konno, N. (2000). SECI, Ba and leadership: A unified model of dynamic knowledge creation. *Long Range Planning*, *33*(1), 5–34. doi:10.1016/S0024-6301(99)00115-6

Pisano, G. P. (2015). You need an innovation strategy. *Harvard Business Review*, *93*(6), 44–54.

Pustovrh, A., Jaklič, M., Martin, S. A., & Rašković, M. (2017). Antecedents and determinants of high-tech SMEs' commercialisation enablers: Opening the black box of open innovation practices. *Economic Research-Ekonomska Istraživanja*, *30*(1), 1033–1056. doi:10.1080/1331677X.2017.1305795

Rajapathirana, R. J., & Hui, Y. (2018). Relationship between innovation capability, innovation type, and firm performance. *Journal of Innovation & Knowledge*, *3*(1), 44–55.

Ruiz-Jiménez, J. M., & Fuentes-Fuentes, M. d. M. (2016). Management capabilities, innovation, and gender diversity in the top management team: An empirical analysis in technology-based SMEs. *BRQ Business Research Quarterly*, *19*(2), 107–121. doi:10.1016/j.brq.2015.08.003

Sako, M. (2004). Supplier development at Honda, Nissan and Toyota: Comparative case studies of organizational capability enhancement. *Industrial and Corporate Change*, *13*(2), 281–308. doi:10.1093/icc/dth012

Sarfraz, I., Rajendran, D., Hewege, C., & Mohan, M. D. (2018). An exploration of global employability skills: A systematic research review. *International Journal of Work Organisation and Emotion*, *9*(1), 63–88. doi:10.1504/IJWOE.2018.10012435

Singh, J., & Singh, H. (2015). Continuous improvement philosophy – Literature review and directions. *Benchmarking: An International Journal*, *22*(1), 75–119. doi:10.1108/BIJ-06-2012-0038

StataCorp (2013). *Stata: Release 13. Statistical software*. College Station, TX: StataCorp LLC.

Tsuji, M., Shigeno, H., Ueki, Y., Idota, H., & Bunno, T. (2017). Characterizing R&D and HRD in the innovation process of Japanese SMEs: Analysis based on field study. *Asian Journal of Technology Innovation*, *25*(2), 367–385.

Wooldridge, J. M. (2005). *Introductory econometrics: A modern approach* (3rd ed.). Mason, OH: South-Western.

Wooldridge, J. M. (2010). *Econometric analysis of cross-section and panel data* (2nd ed.). Cambridge, MA: MIT Press.

Yam, R. C., Lo, W., Tang, E. P., & Lau, A. K. (2011). Analysis of sources of innovation, technological innovation capabilities, and performance: An empirical study of Hong Kong manufacturing industries. *Research Policy*, *40*(3), 391–402. doi:10.1016/j.respol.2010.10.013