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# INNOVATION AND PRODUCTIVITY IN INDONESIAN IT CLUSTERS: THE INFLUENCE OF EXTERNAL ECONOMIES AND JOINT ACTION

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## ABSTRACT

Literature studies indicate that information technology (IT) clusters encourage innovation and increase firm-level productivity by providing external economies and facilitating joint action for its members. The purpose of this study is to identify the external economy and joint action factors that affect firm innovation and productivity in the IT cluster. A research model was developed based on earlier models of joint action and external economies. The model consists of three external economy related factors, i.e., access to skills, finance, and infrastructure, as well as three joint action related factors, i.e., vertical, horizontal, and research and development (R&D) cooperation as the independent variables, firm innovation as the intervening variable, the firm's absorptive capacity as the moderating variable, and firm productivity as the dependent variable. Data collection was conducted through a survey with respondents from 32 IT firms located in three clusters in Bandung and one cluster in Cimahi (West Java – Indonesia). The partial least square (PLS) approach was used for hypotheses testing. The results indicate that horizontal cooperation, access to infrastructure, and access to skill have a positive impact on productivity, while horizontal cooperation and R&D cooperation have a positive impact on innovation. Finally, firm innovation is proven to positively influence firm productivity.

*Keywords:* Cluster; Indonesia; Information technology; Innovation; Productivity; PLS

## 1. INTRODUCTION

Clusters have long been believed to be quite effective in improving industry competitiveness due to the locality. The literature on clusters suggests that being located within an interrelated firm center is key to firm innovation and performance (Porter, 2000; Eickelpasch et al., 2007). Thus, the cluster encourages innovation, productivity improvement, improved cooperation, and synergy among relevant actors (Porter, 2000; Huber, 2012; Terstriep & Luthje, 2012).

In this article, the term "cluster" refers to a geographical agglomeration of firms operating in related industries (Huber, 2012). One famous example of a successful cluster is Silicon Valley. The term "IT cluster" represents a zone accommodating high-tech companies that make use of that zone's infrastructure for the purpose of developing or producing information technology or software products. In the zone, these companies can commercialize an existing high-tech invention into a product, a method, or a service. The IT cluster is arranged in such a way that it can aggregate the academic, economic, and social frame and is aimed at contributing to the region's economic development.

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Hamid et al. (2011) defined productivity as the utilization of various resources or inputs within the organization to achieve the expected or planned results. The concentration of companies in one location encourages the concentration of specialized labor, thus benefiting the companies and the workforces. Thus, the concentration of related companies and industries can improve efficiency by better and more cheaply meeting the demand for specialized inputs, thus increasing productivity (Porter, 2000).

Silicon Valley's success has encouraged researchers from different countries to try to identify and understand the success determinants of a cluster and the companies within it (e.g., Eickelpasch et al., 2007; Rabellotti, 1999). An analysis of previous studies found that cluster members' innovation and performance can be stimulated by factors related to external economies and joint action. These two aspects determine the success of the cluster as a whole.

Examining this in more detail, it appears that previous studies were focused on only one of the themes: externality, or joint action. The research of Terstriep and Luthje (2012), and Rabellotti (1996) focuses on the effects of joint action, while Dutz and O'Connell (2013) examine externalities' influence on clusters. Eickelpasch et al. (2007) examine the effect of both externalities and joint action, but the factors were used in a more aggregated manner, so detailed analyses were still missing. In this research, a model was developed that combined the two themes, external economies and joint action, as the groups of antecedents that influence the clusters' productivity and innovation. Models developed by Terstriep and Luthje (2012), Dutz, and O'Connell (2013) were used as the primary basis for developing the research model. By examining the factors in more detail, it is expected this study's results will provide stakeholders (entrepreneurs, cluster managers, or the government) with better recommendations for formulating policies or strategies to increase Indonesia's economy through industrial clusters.

## 2. METHODOLOGY

### 2.1. Model Development

Drucker (1988) defines innovation as an action providing resources that give new strength and the ability to create wealth. According to McFadzean et al. (2005), innovation is a process that provides added value and a degree of novelty to the organisation and its suppliers and customers through the development of new procedures, solutions, products and services as well as new methods of commercialisation. Looking at innovation as a process, it can also be described as a lengthy, interactive, and social concept involving various people from various backgrounds and competencies (Leadbeater, 2003). Innovation can further be seen as the changes in the products or services being created and delivered to the end users (Tidd et al., 2005).

Clusters also play a role in fostering innovation (Poon et al., 2013). By becoming a member of a cluster, a company can better access various innovation and development advantages, compared to an isolated company. Cluster members tend to be more quickly become aware of trends in consumer wishes compared to isolated competitors. Besides that, cluster members receive advanced knowledge about opportunities for developing new technologies and operating processes, information related to emerging technologies and components, and information on the availability of machinery, services, and marketing concepts. The relationship with other institutions in the cluster (including educational institutions) facilitates a variety of learning opportunities through the frequent contact, which allows, for example, direct observation of other companies. Companies that are isolated, on the other hand, need to invest more because they need to collect the information by themselves and do in-house R&D. Companies in a cluster can more easily obtain new parts, services, machinery, and other elements necessary for innovation, either in the form of product or process innovation. Local suppliers or partners can also be involved in the innovation process, allowing the input they provide to the company to match the expectations.

Research by Hervas-Oliver et al. (2009) revealed that clusters can affect the way companies combine internal resources (skills, in-house R&D, and marketing) and externally owned resources (location, institution, and linkage), and they found that this can affect innovation and productivity. The research of Eickelpasch et al. (2007) focused on the location factor's impact on innovation and performance at the corporate level. His research shows that the location and the intensity of cooperation (between related and supporting industries) can encourage company innovation, but strong competition (rivals) and a locally focused market (demand condition) inhibits innovation and company performance. Rabellotti (1999) noticed that externalities created by the vertical cooperation undertaken by companies, i.e., the knowledge acquired by the company, is useful not only for the company itself, but for all members of the cluster. A study by De Noni et al. (2013) showed that environmental competitiveness encourages companies to optimize the use of existing resources, while environmental dynamism contributes to improvement in companies' cognitive ability to establish cooperation and collaboration, which impacts innovation within the cluster. Dutz and O'Connell (2013) noticed the external economies' influence on productivity. The results showed a strong relationship between productivity and connectivity to global knowledge, productive entrepreneurship incentives, and skill and finance access. Access to infrastructure does affect productivity, albeit weakly.

The model developed in this study is presented in Figure 1. The figure shows the relationship between the three external economy dimensions and the three joint action dimensions with the company's productivity and innovation. The three dimensions of external economies consist of access to skills, finance, and infrastructure, adopted from Eickelpasch et al. (2007), Dutz, and O'Connell (2013). Meanwhile, the three joint action dimensions consist of vertical, horizontal, and R&D cooperation, adopted from Terstriep and Luthje (2012), and Rabellotti (1999).

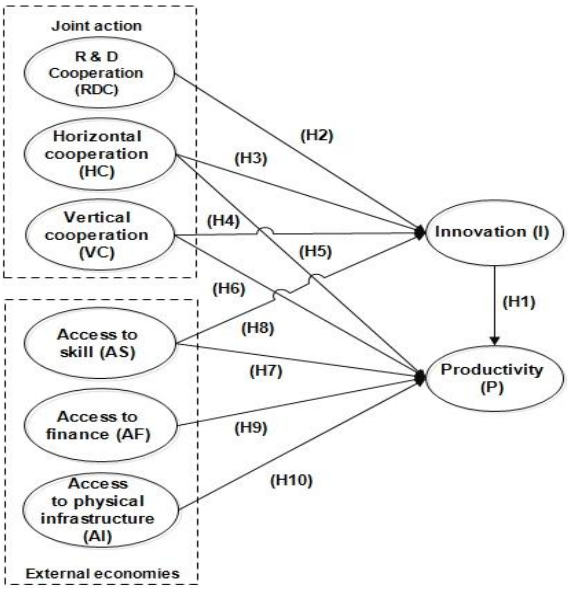


Figure 1 Conceptual research model

### *2.1.1. The influence of innovation on productivity*

Terstriep and Luthje (2012) figured that because companies faced competition both inside and outside the cluster, they are required to continuously innovate in order to maintain competitiveness in a dynamic market. Therefore, it can be assumed that a company's increased innovation ability will positively impact the company's performance as a whole. Based on this argument, the following hypothesis was formulated:

*Hypothesis 1: Innovation has a positive effect on productivity.*

### *2.1.2. The influence of joint action*

Cooperation is fundamental in stimulating and strengthening companies' innovation capabilities (Terstriep & Luthje, 2012). Schmitz (1997) distinguishes two types of joint action: the cooperation of individual companies (e.g., sharing equipment or new product development) and the cooperation of groups of companies joined in business associations, producer consortia, and the like. The two types of joint action are subdivided into two kinds of cooperation, namely, horizontal cooperation (between competitors) and vertical cooperation (between producer and user, or between producer and seller).

The relationship between companies and external institutions is a key element in the development of new knowledge for companies with innovative strategies. Moreover, empirical evidence shows that the proximity of universities to companies encourages the exchange of ideas and improves the companies' innovation performance. Hervas-Oliver et al. (2009) argued that the main motive for companies to cooperate in R&D is access to new knowledge instrumental for innovation, while the motive for universities to engage in cooperative R&D is to obtain revenue to finance the equipment and researchers involved in innovation, as well as having an opportunity to test theories in practice. In this partnership, the university's role is especially important as a creator of technology and a provider of human resources, as well as in aligning economic changes or developments with changes in society. Based on this explanation, we expect that R&D cooperation between companies and universities or research institutes that are part of the cluster will affect innovation.

When located in a cluster, companies receive benefits in the form of better cooperation and relationship quality. In addition, cooperation on projects related to innovation and/or knowledge transfer will contribute to the success of companies' innovations (Terstriep & Luthje, 2012; Govindaraju et al., 2015; Saenz et al., 2012; Andrawina & Govindaraju, 2009). Rabellotti (1999) suggested that vertical and horizontal cooperation positively affect company performance, as company cooperation will lead to externalities. In this case, information obtained from consumers will not only be useful for the company itself, but the other companies in the cluster as well through knowledge spillover. Vertical cooperation can take the form of backward cooperation with suppliers and subcontractors or forward cooperation with consumers and customers. Horizontal cooperation can take the form of joint production, joint marketing, and order sharing, or sharing knowledge (Rabellotti, 1999).

Based on the explanations above, the following hypotheses were developed:

*Hypothesis 2: R&D cooperation has a positive effect on innovation.*
*Hypothesis 3: Horizontal cooperation has a positive effect on innovation.*
*Hypothesis 4: Vertical cooperation has a positive effect on innovation.*
*Hypothesis 5: Horizontal cooperation has a positive effect on productivity.*
*Hypothesis 6: Vertical cooperation has a positive effect on productivity.*

### *2.1.3. The influence of external economies*

External economies are economic activities performed by a person or institution that (positively or negatively) affect economic activities of other parties, which is not reflected in market prices (Dutz & O'Connell, 2013). A trusted cluster can generate externalities that are beneficial for the companies within it. External economies can appear in the form of access to skills, finance, and infrastructure.

Companies in an active cluster will have access to a specialized and experienced workforce, thereby reducing the company's recruitment costs (Porter, 1998). Hard locational factors (especially the indicators of university proximity and the availability of a competent workforce supply) affect innovation and company performance (Eickelpasch et al., 2007). Furthermore, Dutz and O'Connell (2013) concluded that skill access affects companies' productivity.

Access to capital and financial means is essential for companies to develop their business, and clusters can provide better access to capital. Companies that are in the early stages of developing their ideas often receive capital support from private investors. This is in line with Porter (1998), who stated that clusters could attract venture capital. Good access to both venture capital and private investors can certainly increase the company's chances for attracting funding. Related to that, Eickelpasch et al. (2007) observed in their research that soft locational factors (including the indicator of local financial institution support) also affect companies' performance. Furthermore, it has been proven that there is a strong relationship between productivity and financial access (Dutz & O'Connell, 2013).

With a concentration of supplier input and buyer output in one location (as in the case of industrial clusters), companies' transaction costs will be lower. Furthermore, Ali et al. (2010) notice that the reduction in transaction costs minimizes the initial capital required to start a business. Therefore, the cluster is very important in helping to lower the costs of coordination and facilitating transactions through physical and social proximity.

Based on the explanations above, the following hypotheses were developed:

*Hypothesis 7: Access to skills has a positive effect on productivity.*
*Hypothesis 8: Access to skills has a positive effect on innovation.*
*Hypothesis 9: Access to financing has a positive effect on productivity.*
*Hypothesis 10: Access to infrastructure has a positive effect on productivity.*

## 2.2. Reseach Design

### *2.2.1. Research sample and data collection process*

For the purpose of data collection, a set of questionnaires was prepared. The questions included did not require descriptive answers; they were designed so that respondents could compare the statements with their perceptions of the facts by selecting the most appropriate option, on an interval from 1 (strongly disagree) to 10 (strongly agree) for each response.

This study uses the purposive sampling technique; the selected samples were restricted to companies active in the telecommunications industry located in a cluster in the cities of Bandung and Cimahi. The companies that participated in this survey are located within four clusters. The questionnaires were distributed to the companies in either face-to-face meetings or indirectly through managers, or through Google Drive. The survey was conducted from November until December 2014. The respondents include the companies' managers, supervisors, or owners. A total of 35 questionnaires were distributed, the same as the number of tenants in all four locations. Of the 35 companies surveyed, 3 companies were not available to fill out the questionnaire. A total of 32 responses were processed (91.4% response rate). The demographic characteristics of the participating firms are presented in Table A (see Appendix).

### *2.2.2. Data processing*

PLS path modeling was used to perform the data analysis, as PLS is a variance-based SEM technique. It can be used in structural model measurement, small samples, explorative studies aimed at testing, and validating a model (Hair et al., 2010). There were two data analysis stages: the first stage analyzed the measurement model (outer model) in order to determine the validity and reliability connecting indicators with latent variables; the second stage analyzed the structural model (inner model). The structural model was evaluated using the R-square ($R^2$) test for the dependent construct, the Stone-Geisser Q-square test for predictive relevance, and the t-test for the structural parameters. The $R^2$ test can be used to assess independent latent variables' effect on dependent latent variables in order to determine whether there is a substantive influence. Chin (1998) described the criteria for the thresholds by dividing $R^2$ into three classes, namely, 0.67 for substantial, 0.33 for moderate, and 0.19 for weak. Aside from looking at the R-square value, the PLS model was also evaluated by looking at the Q-square predictive relevance in order to gauge how well the observed values were generated by the model and how well the parameters were estimated. A Q-square value greater than 0 (zero) indicates that the model has predictive relevance, while a Q-square value less than 0 (zero) indicates that the model lacks predictive relevance.

## 3. RESULTS

### 3.1. Reliability and Validity of Measures

The internal reliability was checked through examination of the values of the composite reliability (CR) values and Cronbach's alpha. The CR values for all constructs were between 0.8321 and 0.9830, which means that they were all above the threshold of 0.6 (Chin, 1998). For the Cronbach’s alpha values, there was one construct with a value below 0.6, namely, vertical cooperation, which had a value of 0.5972. Nevertheless, because the CR value of vertical cooperation was greater than the limit, the vertical cooperation construct can still be included in the model.

The reliability of the indicators can be seen from the outer loading value for all items in the model. The absolute value of standardized outer loading is in the range of 0.6111 to 0.9717, as shown in Table B (see Appendix). According to Chin (1998), an outer loading value greater than 0.5 is acceptable. This shows that the model is reliable. Discriminant validity can be determined from the root of AVE and the cross-loadings. The values of all indicator’s outer loadings are greater than the value of their cross-loadings, and these results indicate that the model has good discriminant validity (Chin, 1998). Convergent validity can be seen from the value of AVE. All constructs have AVE values greater than the threshold of 0.5 (Chin, 1998). This shows that all of the constructs are valid. The correlation and discriminant validity test results are presented in Table 1.

Table 1 Correlation and discriminant validity

| | AF | AI | AS | HC | I | P | RDC | VC |
|---|---|---|---|---|---|---|---|---|
| AF | **0.9576** | | | | | | | |
| AI | 0.456 | **0.8594** | | | | | | |
| AS | 0.297 | 0.608 | **0.8643** | | | | | |
| HC | 0.278 | 0.753 | 0.623 | **0.8772** | | | | |
| I | 0.025 | 0.560 | 0.502 | 0.796 | **0.8317** | | | |
| P | 0.318 | 0.789 | 0.743 | 0.819 | 0.707 | **0.9349** | | |
| RDC | 0.114 | 0.339 | 0.483 | 0.437 | 0.628 | 0.585 | **0.8561** | |
| VC | 0.299 | 0.364 | 0.103 | 0.351 | 0.084 | 0.142 | -0.316 | **0.8441** |

### 3.2. Evaluation of the Structural Equation Model

In order to test the hypotheses, we looked at the significance of the path coefficients in this model’s 10 paths. This study used the bootstrapping technique with resampling set at 500 times.

The results are presented in Table 2.

Table 2 Assessment of path analysis

| Paths | Standardized coefficient | t-statistic | Supported alternative hypothesis |
|---|---|---|---|
| **H1.** I -> P | 0.114795 | 1.684050 | **Yes** |
| **H2.** RDC -> I | 0.267385* | 3.272635 | **Yes** |
| **H3.** HC -> I | 0.577867* | 5.868211 | **Yes** |
| **H4.** VC -> I | -0.03156 | 0.230568 | No |
| **H5.** HC -> P | 0.350842* | 3.265973 | **Yes** |
| **H6.** VC -> P | -0.15407 | 1.220680 | No |
| **H7.** AS -> P | 0.262587* | 3.710858 | **Yes** |
| **H8.** AS -> I | -0.11012 | 1.042208 | No |
| **H9.** AF -> P | 0.032074 | 0.548711 | No |
| **H10.** AI -> P | 0.343089* | 5.058591 | **Yes** |

From the structural model evaluation results, presented in Table 2, the present researchers found that in an IT cluster, R&D cooperation and horizontal cooperation have significant effects on innovation, while horizontal cooperation, access to skill, and access to physical infrastructure affect the firms' productivity within a cluster.

## 4. DISCUSSION

Cooperation is a very important factor for boosting innovation and productivity. Without good cooperation accompanied by a sense of trust between members of a cluster, a vision that has been set together will be difficult to achieve. Working together allows companies to exchange information and ideas related to products, processes, and operations, as well as marketing. In this case, the role of a manager in a cluster is important for mediation and driving cooperation among cluster members.

The availability and quality of infrastructure in the cluster is also very important for the companies' productivity, and therefore, the cluster managers need to work with the government and the private sectors in order to develop infrastructure within the cluster and the surrounding area, as this allows them to support the industrial activities. The research results also revealed the influence of skill access and R&D cooperation on productivity and innovation. It is important for an ideal cluster to be equipped with educational institutions and research facilities.

The fact that financial access has no significant influence on productivity indicates the companies' perception that, although it is still difficult for the company to obtain a bank loan or venture capital, the company can still run its operations well. In other words, the company's operation can still be met through private funding from the company owner.

This study also found that vertical cooperation has no significant effect on either productivity or innovation in an IT cluster. The data collected revealed that vertical cooperation intensity in the cluster remains low. On average, companies are supplied with necessary goods or services from outside the cluster. In addition, the orders or projects that are awarded to the companies are predominantly coming from outside the cluster. Although each company's products differ from each other, they are still of the same product type. Because of that, the companies tend to operate individually, and their production activities are not associated with those of other companies. Moreover, strong competition between companies can exist. In this situation, innovations developed by one company (especially in the form of product innovations) will not be voluntarily shared with other competitor companies. In other words, mutual trust among cluster members has not been established.

As with other studies, this study has some limitations. The first limitation is related to the sampling method used. The number of samples taken in this study is relatively small for a model with so many variables. Hair et al. (2010) stated that the ratio of the number of observations to the number of variables should at least be 5:1. By increasing the sample number, a stronger statistical test can be achieved. The larger the sample size, the more accurately the sample would reflect the population. Further research can focus on increasing the number of samples. Finally, further research can be done by comparing the influence of external economies and joint action on the IT industry inside a cluster versus on isolated IT companies in order to understand the cluster's benefits for companies more clearly.

## 5. CONCLUSION

The results of this study confirm that innovations that take place within companies in an IT cluster can increase the individual company's productivity. Furthermore, this study also found that of the five variables hypothesized to have an effect on productivity, four were confirmed to be influential, namely, innovation, horizontal cooperation, access to infrastructure, and access to skill. Of the four variables hypothesized to have an effect on innovation, only two were confirmed to be influential, namely, horizontal cooperation and R&D cooperation.

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## Appendix

Table A. Demographic characteristics of the participating firms

| Characteristics | Number of respondents | % |
|---|---|---|
| *Company classification* | | |
| - Micro enterprise (nr of employees < 10) | 26 | 81% |
| - Small enterprise (nr of employees ≤ 30) | 6 | 19% |
| *Type of business* | | |
| - Reproduction of film and video recordings (animation) | 6 | 19% |
| - Software and hardware | 25 | 81% |
| *Company age* | | |
| - More than 5 years | 1 | 3% |
| - 3–5 years | 7 | 22% |
| - Less than 3 years | 24 | 75% |

Table B. Cross-loading

| | AF | AI | AS | HC | I | P | RDC | VC |
|---|---|---|---|---|---|---|---|---|
| **AF1** | 0,951 | 0,411 | 0,208 | 0,252 | 0,047 | 0,279 | 0,089 | 0,293 |
| **AF2** | 0,964 | 0,46 | 0,35 | 0,279 | 0,005 | 0,326 | 0,127 | 0,281 |
| **AI1** | 0,25 | 0,856 | 0,485 | 0,684 | 0,6 | 0,647 | 0,323 | 0,268 |
| **AI2** | 0,456 | 0,893 | 0,585 | 0,683 | 0,585 | 0,744 | 0,432 | 0,224 |
| **AI3** | 0,464 | 0,829 | 0,489 | 0,571 | 0,242 | 0,636 | 0,095 | 0,464 |
| **AS1** | 0,224 | 0,537 | 0,885 | 0,573 | 0,521 | 0,651 | 0,541 | 0,019 |
| **AS2** | 0,29 | 0,513 | 0,842 | 0,503 | 0,344 | 0,633 | 0,29 | 0,16 |
| **HC1** | 0,157 | 0,648 | 0,59 | 0,895 | 0,711 | 0,71 | 0,313 | 0,387 |
| **HC2** | 0,286 | 0,695 | 0,526 | 0,862 | 0,656 | 0,765 | 0,442 | 0,26 |
| **HC4** | 0,289 | 0,638 | 0,524 | 0,875 | 0,727 | 0,677 | 0,396 | 0,275 |
| **I1** | -0,004 | 0,596 | 0,594 | 0,761 | 0,907 | 0,787 | 0,635 | 0,066 |
| **I2** | 0,122 | 0,408 | 0,133 | 0,549 | 0,774 | 0,423 | 0,513 | -0,063 |
| **I3** | -0,042 | 0,348 | 0,454 | 0,653 | 0,805 | 0,479 | 0,382 | 0,211 |
| **P1** | 0,395 | 0,78 | 0,732 | 0,835 | 0,649 | 0,942 | 0,448 | 0,2 |
| **P2** | 0,188 | 0,69 | 0,654 | 0,688 | 0,675 | 0,927 | 0,657 | 0,058 |
| **RDC2** | 0,048 | 0,324 | 0,391 | 0,373 | 0,59 | 0,476 | 0,888 | -0,284 |
| **RDC3** | 0,16 | 0,25 | 0,444 | 0,378 | 0,476 | 0,536 | 0,822 | -0,256 |
| **VC1** | 0,169 | 0,275 | 0,03 | 0,252 | 0,017 | 0,158 | -0,208 | 0,848 |
| **VC2** | 0,344 | 0,342 | 0,149 | 0,344 | 0,129 | 0,078 | -0,33 | 0,841 |