The Use of Absorptive Capacity in Improving the New Product Development (NPD)

W Gunawan¹, P Gerardus¹², B J Tji¹², and K Richard¹²
¹Faculty member, Master in Information Systems Management,
²Senior Faculty member, DRM Programmes, Bina Nusantara University.

Abstract. The term Absorptive Capacity (AC) refers to maximizing the external knowledge transfer into the organization in order to improve its performance. Since its introduction in year 1990, AC has been applied widely in many fields such as: economy, business, KM, HR, intellectual capital, IT, operation management, marketing, etc. Due to its wide application, nevertheless, The AC application in both Indonesian industry and higher education institutions (HEIs) are still rare to find. The Indonesian Directorate General of Higher Education (DGHE) has encouraged creating effective collaboration model that enables to link the HEIs with the industries in order to improve knowledge creation in improving product development that can be used by the firms. For this reason, the article examines the effective AC model that enables to assist in improving new product development (NPD) process in the polytechnic perspectives.

1. Introduction

Researchers have found that firms that use many other external sources of knowledge such as competitors, suppliers, and customers, private institute, trade fairs and associations etc. also tend to use the higher education research more intensively (1) (2). Prior knowledge of collaboration allows the higher education institutions (HEIs) to assimilate and exploit new knowledge, and enhance its learning capabilities and AC (3). Li emphasizes that global research and development (R&D) literature portrays international R&D conducted by multinational corporations (MNCs) have begun to draw on new sources of innovation such as local HEIs for knowledge creation and new product development (NPD). Li addressed that many HEIs are shifting from long-term research to near-term research and commercialization of research output.

The HEIs have traditionally provided know-how (skills and capability), and know-why (general principles and laws), and they need partner that can focus on commercializing the knowledge (4). The DGHE enables the HEIs to take role in offering the consultancy services, and entering into industry collaborative relationship expansion into acquiring know-what (facts) and know-who (establishing the relationships).

The national government states the important role of the HEIs in the national master plan (5) to support the growth of SMEs and large enterprises (5). The leading HEIs are subject to the beneficial reputation effects either in local and global. Inter-organisational ties are effective means to diffuse and transfer the complex knowledge. It enables to create a mutual trust, embeddedness, and social cohesion between partners (6). Petruzelli addressed that firm relationship enables to provide opportunities in:
easy access to wide range of industries; learn the different knowledge from many industries; and link knowledge across industries and sectors. The HEIs have the ability to recombine and integrate the external knowledge and act as knowledge brokers that span multiple markets and technology domains and transfer the knowledge for any company that needs it. These effects lead to the improvement of innovation performance of the polytechnics as measured for instance, by patent applications and registrations (4).

The article examines the needs of applying the absorptive capacity (AC) term, to acquire the firm (external) knowledge and internalize it into product development in the state-owned polytechnics. The state-owned polytechnics are selected due to their strategic position in the national economic development plan (5).

2. Theoretical Framework

2.1. Application Absorptive Capacity (AC) in Higher Education Institutions (HEIs).

Improving the AC in the HEIs is not an easy task (7). Huggins et.al. (4) warn that the collaboration of higher education and firms contains high complexity and can easily ends up in failures. The article addresses the major problems faced by state-owned polytechnics from the AC perspectives such as: (a) major polytechnics and firms have few clues on what they expect from each other. The firms have very little clue on acquiring the academic knowledge owned by the HEIs; on the other hand, the HEIs have difficulty to transform the academic knowledge into practical knowledge (8) that can be commercialized by the firms. Both parties may experience many difficulties on maximizing the knowledge transfer in NPD (1) (6); (b) Lack of collaboration model has led to the difficulty of assessing the knowledge transfer from firms to polytechnic and vice versa (9).

Broring et.al. (10) addressed the important of all firms to collaborate with the HEIs in creating value in their NPD process. Broring et.al. encourage the firms to search academic partnerships in: patent development, literature analyses, conference attendance and close contact with the leading universities or polytechnics. They argue that firms should be aware of their competence gaps, and needs to improve their AC in order to improve front-end of the NPD process.

The idea of improving AC in supporting industry’s NPD has limited application for the state-owned polytechnics in Indonesia, where there are wide disparities amongst those polytechnics on maximizing and internalizing the knowledge transfer with the firms. Studies conducted by the U.S. National Science Foundation (NSF) (11), show that most of collaboration programmes end up in failures. NSF noted that most HEI faculties gained experience in competing for and managing federal research projects, however they have not learned how to develop and manage cooperation research framework. Edmondson addressed the collaboration problems lies on the gap of understanding framework, experience and skills required in the collaboration.

The active role of stakeholders determines the successful of HEIs collaboration with the firms. There are several important factors affect to the collaboration such as (11): understanding the nature of polytechnic and firms; multidisciplinary and cross-cultural approach to research and learning; shared vision and develop a clear strategy, is important to determine the successful of collaboration, and to be supported with the appropriate AC framework; rethinking the roles of traditional Technology Transfer Office (TTO), as the main mission to support the activity of research and community/industry service; formalization of the partnerships; other important factors are not discussed in the article due to its low relevance to the AC framework, such as entrepreneurship skills, time devotion and full commitment from top management of both higher education institutions, etc.

The concept of AC (12) can be applied in all these steps through emphasizing the collaboration with the firms as important external sources with following activities such as (13): (a) NPD is a business process that is highly knowledge-intensive. It needs the involvement of the firms (customers) as key business actor for creating new organizational knowledge; (b) NPD projects are under pressure to accelerate development cycles and decrease development costs, while increasing designing quality and flexibility; (c) From learning perspective for an organisation, NPD is the context from which the
organization is most likely to transfer methods (resources and capabilities) to other areas of the organization; (d) In NPD, customer knowledge-related activities play a critical role, and thus provide excellent leverage points for support system and AC model enhancement; (e) NPD projects are increasingly using customer sources and other external resources to overcome the learning curves related to new market and new technologies; In order to measure the final NPD success, the article examines the indicators such as: time, economy, market, and quality (14).

Zahra and George (15) addressed the importance of AC comprised of two main domains: potential absorptive capacity (PAC), and realised absorptive capacity (RAC). The article examines the PAC and RAC (16), and relate them with the determinant factors such as: ideation, prior-customer related knowledge, and motivation (17), as important steps to produce the new product advantage (NPA) (14).

2.2. Ideation (Id)

Ideation process is summarized into: (a) ideation relates to the PAC (Idpac), refers to getting important external (firm) idea and insights of the product design; (b) ideation relates to the RAC (Idrac), refers to internalising the idea into creating production methods/procedures (18).

2.3. Prior Customer-related Knowledge (Pkmpac).

The prior customer-related knowledge (Pkmpac) generally differs from one customer to the other, and it determines the experience of using the product (19). Hausberg (20) suggests that the more firms try to absorb the knowledge from HEIs, the easier they will approach and absorb knowledge from them.

2.4. Motivation (Mot)

Individuals with high motivation will likely be able to increase invention experience to select the creative ideas from groups that is at the frontier of knowledge and solution development. Motivation factor relates with PAC (motpac), refers to the firm (external) knowledge acquisition process, while the motivation factors relates with RAC (motrac), to relates with the transformation of external knowledge into creating effective production methods and creating new product advantage (NPA) (15).

2.5. Support System (SS)

Support System (SS) refers to the use of IT tools to support the entire AC process. It can be done through intra/inter organisational networks, such as: intranet and extranet. The role of SS (21) (22) in PAC (sspac) refers to gathering firm’s (customer) knowledge in order to improve the collaboration firm-polytechnic. The role SS in RAC (ssrac), refers to setting up collaboration networks with external source that enables open collaboration networks through internet technologies.

2.6. Project Complexity and Risk (Pro)

Scholars agree that project structure plays important role in both acquiring the firm knowledge (PAC) and creating NPA (23). It depends highly on the structure (phase) of the project in dealing with complexity and risk (20). The NPD framework comprised of the following steps (adapted from (10)): project visualization (actions, interactions, commitments and customizes product definition); project planning (making commitments, choosing activities, structuring the process, estimating, optimizing, and improving key variables (time, cost, etc.); allocating resource; and project execution and control (monitoring commitments, assessing progress, re-directing and re-planning); and project development (continuous improvement, organisational learning and knowledge management, training, setting up metrics and compliance).

2.7. Environmental Turbulences (etrac)

The nature of NPD is generally affected by environmental turbulence in the stage of the realising the external knowledge in product development (RAC) such as (6): (a) high uncertainty, refers to the nature of business competition marked by the dynamic changing of customer’s needs and competition; (b) information asymmetries, refers to the gap of information takes place amongst the firms, customers and polytechnics; (c) transactional costs. The factors of high uncertainty and asymmetric information enable to escalate the transactional (hidden) costs of the collaboration; (d) appropriability hazards. In case of
high competition, market information processing is thought to be crucial for quick and adequate reaction in order to move and adapt. Similarly, the processing of superior market insights is important in highly turbulence markets, where it requires firms to continuously uncover changing customer preferences and quickly adjust product offerings to meet these most current needs (14).

2.8. New Product Advantage (NPA)

The term NPA is used as an indicator to measure the successful of the collaboration with the firm (24). Customers are more likely to purchase a new product/service when it offers superior features and unique benefits that cannot found in products that already exist in the market (25). Product/service advantage appears as the most important product characteristic in explaining the adoption and success of the new product (26). Langerak et.al. (27) further addressed the importance of creating market-oriented culture to ensure that new products help customers achieve their production objectives. It can be done through attaching the customer collaboration as the essential factor of creating market-oriented culture.

3. Research Model

The formulation of hypotheses of AC model are summarized as follows: (See figure 1)

- H1: Acquiring the prior firm (customer) related knowledge (Pkm-PAC) is important to encourage the creativity process in inventing product ideation in the collaboration process (Id-PAC).
- H2: The prior firm (customer) related knowledge (Pkm-PAC) delivers the strong roles in the improving the Potential Absorptive Capacity (PAC).
- H3: The prior firm (customer) related knowledge (Pkm-PAC) is important to increase the motivation in collaborating with the (firms) customer (Motpac).
- H4: Acquiring the product ideation from firm (customer) (Id-PAC) is important to encourage creating important idea to select appropriate production method (Id-RAC).
- H5: Motivation that involves in acquiring the firm knowledge (Motpac) is important to improve potential absorptive capacity (PAC).
- H6: The firm collaboration motivation (Motpac) is important to increase the motivation in the entire production process (Motrac).
- H7: The Potential Absorptive Capacity (PAC) delivers strong impact in increasing the Realised Absorptive Capacity (RAC).
- H8: Motivation that involves in the production is important to improve the Realised Absorptive Capacity (RAC).
- H9: The Realised Absorptive Capacity (RAC) delivers the strong impact to creating new product advantage (NPA).

4. Data Collection Method

The questionnaires are designed with the Likert scale of 5, and focused to the staffs that have actively involved in collaboration with the firms. They are ranging from staffs, supervisors, head of programmes, and directors. The population are selected from the 31 national and 17 local state owned polytechnics that are recommended by the DGHE through their reputations and experiences in the firm-polytechnics collaboration. The questionnaires later are processed by using SEM method, with SmartPLS software in order to forecast their results (28) (29) (30).

There are 1000 questionnaires are distributed through e-mails, phone calls, internet forums, seminars, and interviews. From 1,000 questionnaires had been distributed, only 113 had returned and validated. The respondents comprised of 18 (out of 31) national state-owned polytechnics, and 9 (out of 17) local state-owned (Pemda) polytechnics, with 79 respondents from national, and 34 respondents from local polytechnics. See Table 1 and 2 for the distribution of respondents.

Table 1. Distribution of the respondents.
Table 2. Distribution respondents of the institutions.

| No | Title                                      | Polytechnics |          |          |          |          |
|----|--------------------------------------------|--------------|----------|----------|----------|----------|
|    | Vice and Director (Top Managerial Position)| National     | 14       | 8        | 22       |          |
|    | Head of Programme (Middle Management)      | Local        | 25       | 12       | 37       |          |
|    |                                            | Total        | 39       | 20       | 59       |          |
|    |                                            | Total        | 79       | 34       | 113      |          |

Table 3. Summary validity and reliability Test.

| Latent Variable | Convergent Validity (AVE) | Composite Reliability (CR) | Explained Variance ($R^2$) | Communality | Predictive Relevance ($Q^2$) | Status |
|-----------------|---------------------------|-----------------------------|-----------------------------|-------------|-------------------------------|--------|
| Id-PAC          | 0.72                      | 0.88                        | 0.32                        | 0.72        | 0.22                          | valid  |
| Id-RAC          | 0.77                      | 0.91                        | 0.64                        | 0.77        | 0.43                          | valid  |
| Motpac          | 0.56                      | 0.83                        | 0.14                        | 0.56        | 0.06                          | valid  |
| Motrac          | 0.57                      | 0.84                        | 0.71                        | 0.52        | 0.35                          | valid  |
| NPA             | 0.68                      | 0.9                         | 0.22                        | 0.68        | 0.12                          | valid  |
| PAC             | 0.56                      | 0.71                        | 0.39                        | 0.56        | 0.18                          | valid  |
| Pkm-PAC         | 0.51                      | 0.76                        | 0.51                        | 0.51        | 0.06                          | valid  |

5. Findings

Figure 1. Absorptive Capacity (AC) model in the New Product Development (NPD). (Adapted from (14), (15) (31) (32))
Table 3 to 8 show that model is tested valid against several measurements, and eligible for further analysis. Table 7 and 8 Outer Loading shows path coefficients > 0.5, eligible to be used as further prediction to the AC model. Table 9 shows three path coefficients<0.5 or having potential weak effects: (a) H2: the prior firm (customer) related knowledge (Pkm-PAC) delivers the weak roles in the improving the Potential Absorptive Capacity (PAC); (b) H3: the prior firm (customer) related knowledge (Pkm-PAC) does not show important roles to increase the motivation in collaborating with the (firms) customer (Motpac). (c) H6: the firm collaboration motivation (Motpac) does not show important roles to increase the motivation in production process (Motrac). It can be understood, generally, the transfer knowledge mechanism into polytechnics is still relative new, where the firms depend more on the principal products, rather than innovation capability that comes from collaboration scheme with the polytechnics in new product development.

Table 4. Discriminant Validity (Matrix Correlations)

| Latent Variable | AVE  | CR   | Communality |  \(Q^2\) | Status |
|-----------------|------|------|-------------|----------|--------|
| Id-PAC          | 0.72 | 0.88 | 0.72        | 0.22     | valid  |
| Id-RAC          | 0.77 | 0.91 | 0.77        | 0.43     | valid  |
| Motpac          | 0.56 | 0.83 | 0.56        | 0.06     | valid  |
| Motrac          | 0.57 | 0.84 | 0.52        | 0.35     | valid  |
| NPA             | 0.68 | 0.9  | 0.68        | 0.12     | valid  |
| PAC             | 0.56 | 0.71 | 0.56        | 0.18     | valid  |
| Pkm-PAC         | 0.51 | 0.76 | 0.51        | 0.06     | valid  |
| RAC             | 0.64 | 0.84 | 0.64        | 0.3      | valid  |

Note: **Correlation is significant at the 0.01 level (2-tailed) *Correlation is significant at the 0.05 level (2-tailed).
Note: (***) significant with p<0.01, t>2.58 (bootstrapping with case 200 and samples 1000).

### Table 5. Cross-Loadings (Discriminant Validity)

| Indicators   | Path Coefficient | T-distribution (*** | Status |
|--------------|------------------|---------------------|--------|
| Idpac1       | 0.84             | 25.91               | valid  |
| Idpac2       | 0.89             | 24.77               | valid  |
| Compact      | 0.58             | 10.29               | valid  |
| Comrac       | 0.66             | 12.71               | valid  |
| Efpac        | 0.77             | 16.18               | valid  |
| Efrac        | 0.82             | 33.5                | valid  |
| Etrac        | 0.66             | 8.94                | valid  |
| idrac1       | 0.89             | 39.83               | valid  |
| idrac2       | 0.89             | 53.53               | valid  |
| idrac3       | 0.86             | 32.52               | valid  |
| npa1         | 0.76             | 18.91               | valid  |
| npa2         | 0.88             | 33.28               | valid  |
| npa3         | 0.85             | 27.84               | valid  |

### Table 6. Cross-Loadings (Discriminant Validity) (continued)

| Indicators   | Path Coefficient | T-distribution (*** | Status |
|--------------|------------------|---------------------|--------|
| npa4         | 0.81             | 16.8                | valid  |
| pipac        | 0.81             | 17.3                | valid  |
| pirac        | 0.72             | 15.48               | valid  |
| Pkmpac1      | 0.8              | 18.93               | valid  |
| Pkmpac2      | 0.63             | 8                   | valid  |
| Pkmpac3      | 0.7              | 16.16               | valid  |
| propac       | 0.57             | 5.96                | valid  |
| prorac       | 0.89             | 59.45               | valid  |
| sspac        | 0.89             | 36.55               | valid  |
| ssrac        | 0.82             | 33.83               | valid  |
| tdpac        | 0.8              | 25.19               | valid  |
| tdrac        | 0.74             | 22                  | valid  |
| valrac       | 0.64             | 9.79                | valid  |

### Table 7. Outer Loadings (Unidimensionality Validity Type)

| Latent Variable                  | Indicator   | Path Coefficient | T-distribution (*** | R Square |
|----------------------------------|-------------|------------------|---------------------|----------|
| Potential Absorptive Capacity (PAC) | propac -> PAC | 0.57            | 3.79                | 0.39     |
|                                  | sspac -> PAC | 0.89            | 24.77               |          |
| Ideation (PAC)                   | Idpac1 -> Id-PAC | 0.84            | 18.56               | 0.72     |
|                                  | Idpac2 -> Id-PAC | 0.89            | 36.66               |          |
|                                  | Idpac3 -> Id-PAC | 0.82            | 18.56               |          |
| Prior Customer Related Knowledge (PAC) | Pkmpac1 -> Pkm-PAC | 0.8            | 12.44               | 0.39     |
|                                  | Pkmpac2 -> Pkm-PAC | 0.63           | 5.78                |          |
|                                  | Pkmpac3 -> Pkm-PAC | 0.7            | 10.98               |          |
| Motivation (PAC)                 | pirac -> PAC | 0.58            | 7.09                | 0.14     |
|                                  | efpac -> PAC  | 0.77            | 17.11               |          |
|                                  | pipac -> PAC  | 0.81            | 10.37               |          |
|                                  | tdpac -> PAC  | 0.8             | 11.9                |          |

### Table 8. Outer Loadings (Unidimensionality Validity Type) (continued)

| Latent Variable | Indicator   | Path Coefficient | T-distribution (*** | R Square |
|-----------------|-------------|------------------|---------------------|----------|
| Realised Absorptive Capacity (RAC) | prorac -> RAC | 0.89            | 22.79               | 0.53     |
|                  | ssrac -> RAC | 0.82            | 37.32               |          |
|                  | etrac -> RAC | 0.66            | 6.44                |          |
| Idation (RAC)    | idrac1 -> Id-RAC | 0.89           | 27.63               | 0.64     |
|                  | idrac2 -> Id-RAC | 0.89           | 36.26               |          |
|                  | idrac3 -> Id-RAC | 0.86           | 22.24               |          |
| Motivation (RAC) | comrac -> RAC | 0.66            | 8.74                | 0.71     |
|                  | pirac -> RAC  | 0.72            | 10.48               |          |
|                  | tdrac -> RAC  | 0.74            | 14.55               |          |
|                  | valrac -> RAC | 0.64            | 6.87                |          |
|                  | efrac -> RAC  | 0.82            | 21.32               |          |
| New Product Advantage (NPA)    | npa1 -> NPA  | 0.76            | 12.62               | 0.22*    |
|                                  | npa2 -> NPA  | 0.88            | 18.51               |          |
|                                  | npa3 -> NPA  | 0.85            | 15.65               |          |
|                                  | npa4 -> NPA  | 0.81            | 9.88                |          |

(Moderate High)
**Table 9. Summary of Hypotheses Test.**

| Hypothesis Test | Confirm with the findings | Coefficient Path | T- Dist. (*** | Impact |
|-----------------|--------------------------|------------------|--------------|--------|
| H1              | Yes                      | 0.57             | 7.47         | Moderate |
| H2              | No                       | 0.22             | 2.97         | Not Supported |
| H3              | No                       | 0.37             | 4.11         | Not Supported |
| H4              | Yes                      | 0.8              | 16.31        | Significant |
| H5              | Yes                      | 0.84             | 22.9         | Significant |
| H6              | No                       | 0.26             | 2.78         | Not Supported |
| H7              | Yes                      | 0.52             | 4.75         | Moderate |
| H8              | Yes                      | 0.47             | 6.65         | Moderate |
| H9              | Yes                      | 0.82             | 14.16        | High* |

Note: ***significant with p < 0.01, t > 2.58; Bootstrapping with case = 200, samples = 1000; *moderate for exploration research (range from 0.4 to 0.6).

6. Discussion and Summary

The article is a preliminary study to the use of absorptive capacity (AC) concepts in the polytechnics. The findings infer that more efforts need to be done in order to improve the collaboration mechanism to maximize internalization external knowledge into product development. The findings show the ideation process runs smooth from the firms to creating production methods, and high motivation of polytechnics stakeholders to acquire external (firm) knowledge. The area that has potential improvements such as: using the firm knowledge to improve creativity process; flows from potential knowledge into realized knowledge through creating effective production methods; more incentive involves in acquiring firm knowledge and creating production methods; and maximizing knowledge in creating NPA.

The article also emphasizes the roles of support system, project complexity and risk, and managing environmental turbulence as important roles in acquiring the firm knowledge (PAC) and internalize it into creating effective production methods (RAC) domains. The outcome of the article is expected to deliver several objectives: (a) for manager of the polytechnics and firms, The model provides guideline and reference to maximize the knowledge transfer from/to the polytechnics and firms; (b) for the DGHE. The model enables to create an effective model for the polytechnics to collaborate with the firms.

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