

**EFFECTS OF COLLABORATIVE INNOVATION ACTIVITIES,
COLLABORATIVE INNOVATION CAPABILITY, AND
KNOWLEDGE SHARING ON PUBLIC SECTOR'S INNOVATION
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ABSTRACT

Agriculture sector in Indonesia is very important as they are responsible for the overall growth and productivity of the country's economy and in maintaining human life, considering that food is a basic need and human right. Therefore, public sector must find an effective way to achieve higher agricultural productivity, which can be done by collaborating with other firms. Built on knowledge management theory and collaborative innovation theory, this study aims to examine whether there is an effect of collaborative innovation activity (CIA), knowledge sharing (KS), and collaborative innovation capability (CIC) on the innovation performance (IP) either directly, or through moderation with each other to study the mechanism of collaborative innovation process at the Indonesian Agency for Agricultural Research and Development. Regarding the objective and research model, we empirically validate the survey data for 48 Indonesian Agency for Agricultural Research and Development under the Ministry of Agriculture with SEM PLS method. This study prove that joining in collaborative innovation activities is the key to improve their innovation performance, and knowledge sharing plays a mediating role in the relationships between collaborative innovation activities and firm's innovation performance. This study also prove that collaborative innovation capability is not the only factor that determines the success of a company's innovation performance, since the result shows that CIC has no impact on the relationship between CIA to IP, and KS to IP.

Keywords: Collaborative Innovation Activity, Collaborative Innovation Capability, Knowledge Sharing, Innovation Performance

1. Introduction

Agriculture sector in Indonesia is very important as they are responsible for the overall growth and productivity of the country's economy and in maintaining human life, considering that food is a basic need and human right. The sector contributes approximately 14% of the nation's GDP, employs 1/3 of Indonesia's labor force and is dominated by smallholder farmers (93%) (World Bank, 2021). During the Covid 19 pandemic, many Indonesians turned professions into farmers, due to massive layoffs (Pusat Data dan Sistem Informasi Pertanian, 2021). This sector is also faced with a formidable challenge to increase agricultural productivity, especially when combined with climate change and resource scarcity (Potts & Kastle, 2016). To meet those challenges, it is essential to maintain and enhance agriculture's productivity, sustainability, and competitiveness by increasing public sector's innovation performance.

But what interesting is, what is the best strategy that has great potential to increase innovation in public

organizations? Roberts (2000) in Mishra & Shah, (2009) states that a multi-actor collaborative strategy is a solution for the development and implementation of innovation in public sector organizations. This strategy is carried out by joining collaborative innovation activities with external organizations. This can encourage the exchange of relevant knowledge, competencies, and ideas between collaborating organizations so as to increase creative ideas to solve problems. Collaborative innovation can also encourage the integration of ideas into feasible solutions such as choosing which ideas are the most promising, building and testing prototypes, assessing and sharing risks and benefits, and creating a shared commitment to implementing new solutions. Participants in collaborative innovation are public and private organizations that have relevant knowledge, ideas and resources to solve problems. In addition, previous research has shown that collaborative innovation can stimulate mutual creativity, reduce research and development costs, and improve innovation performance.

However just joining in collaborative activities is not enough. There are studies that argue that certain knowledge cannot be easily shared between partners. There is a need for knowledge sharing among cooperating companies, to open up opportunities for mutual learning and to enable all members of this collaborative network to work in a way that creates completely new value (Tan et al., 2016). Therefore, without knowledge sharing, the desired level of innovation performance cannot be guaranteed simply by participating in collaborative innovation activities (C. Wang & Hu, 2020).

Furthermore, to find out more about how the mechanism of the relationship between innovation collaboration activities and innovation performance, this study will discuss another key variable, namely collaborative innovation capability. Collaborative innovation capability is the company's ability to ensure that the knowledge or technology obtained from cooperation partners can be actually captured and utilized (Mishra & Shah, 2009). In other words, collaborative innovation capability explains how collaborative innovation activities and knowledge sharing can be translated into innovation performance.

The agricultural sector is supported by industry players, including companies providing plant seeds, fertilizer companies, and among these actors, the Agricultural Research and Development Center has a very important role and is a central player as the frontline of sustainable community food security. Responding to the community's need for agricultural products, one of the main factors that encourage increased productivity in agriculture is investment in research and collaborative collaboration with other government organizations that result in new innovations such as the creation of new products (Khan et al., 2017). The Public Research Institute is expected to be able to accelerate the cycle and increase innovation in its R&D process (Jaruzelski et al., 2017). In the context of Indonesia, the agencies responsible for agricultural research and development are Research Centers under the Ministry of Agriculture.

Several previous researchers have developed analytical models regarding public sector innovation collaboration and its relationship to innovation performance such as Sørensen & Torfing, (2011); Lopes & Farias, (2020) but unfortunately, these models have not been studied empirically. So to increase knowledge about public sector innovation collaboration, this study will empirically examine how the mechanism between innovation collaboration and its relationship with innovation performance in the context of public sector organizations.

2. Literature Review

This research model is a modification of Wang & Hu, (2020) and Ritala et al., (2015) with 4 main constructs, including: collaborative innovation activities, collaborative innovation capabilities, knowledge sharing, and innovation performance, where each construct consists of several question indicators which are summarized and compiled in one questionnaire. This study uses 3 dimensions of innovation performance: internal performance, technical performance, and social performance (Aryanto et al., 2015).

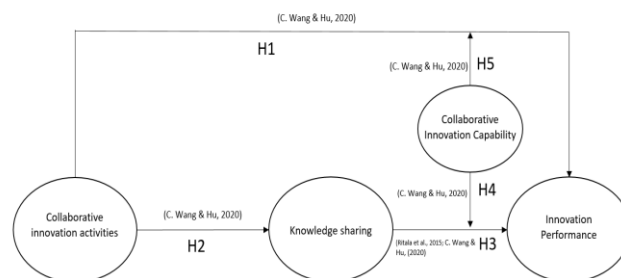


Figure 1 Research Model

(Source: Modification from Ritala et al., (2015); C. Wang & Hu, (2020))

This study develops and empirically tests a research model designed to investigate whether collaborative innovation activities can support the process of knowledge sharing between organizations and external parties. In addition, to see whether collaborative innovation capabilities can be the key to success in the relationship between knowledge sharing and innovation performance in the context of government organizations.

Collaborative innovation activities and innovation performance

Organizations can improve their innovation performance by developing collaborations with various external organizations (Faems et al., 2005), because collaborative innovation activities are information channels that can reduce the amount of time and investment required to collect new information and knowledge (Hildreth & Kimble, 2004) in (C. Wang & Hu, 2020). Collaborative innovation activities should involve two-way communication between collaborating organizations, so as to encourage and facilitate innovative activities by providing the information needed to produce new products. (Cruz-González et al., 2015).

According to Hernandez-Espallardo et al., (2018), There are two reasons why participating in collaborative innovation has a positive effect on innovation performance. First, cooperative partner companies will bring the capacity or knowledge to create valuable innovations. Second, the results of valuable collaborative innovation activities, such as new products and new ways of working, can improve company performance. So it is suspected that organizations that participate in more collaborative innovation activities tend to produce more innovations than organizations that do not carry out optimal collaborative innovation activities. So, the hypothesis raised is as follows:

Hypothesis 1: There is a positive relationship between collaborative innovation activities and innovation performance

Collaborative innovation activities and knowledge sharing

Companies can obtain knowledge from various external sources such as supplier organizations, consumers, and even competitors. Therefore, collaborative activities with external parties are needed to obtain this knowledge. Collaborative innovation activities can build closer ties and can generate mutual trust between collaborating companies. From this mutual trust, companies that work together can access each other's valuable knowledge (Cruz-González et al., 2015). Engaging in collaborative innovation activities stimulate the learning process and innovative thinking of public and private sector actors (Torfing, 2019).

So it is suspected that organizations that participate in collaborative innovation activities can encourage the process of sharing knowledge with external companies, compared to organizations that do not carry out collaborative innovation activities. So, the hypothesis raised is as follows:

Hypothesis 2: There is a positive relationship between collaborative innovation activities and knowledge sharing

Knowledge sharing and innovation performance

According to Wang & Hu, (2020) the observation that collaborative innovation activities have considerable potential to contribute to a firm's innovation performance does not necessarily mean that all collaborations are successful. The knowledge that each company receives is usually not fully accepted by the parties involved in collaborative innovation activities. Knowledge sharing is the process of transferring knowledge, experience, and skills through social interaction between individuals within a department, between departments, or between organizations (S. Wang & Noe, 2010), meanwhile (Lin, 2007) stated, knowledge sharing consists of "the activities of transferring and disseminating knowledge from one person, group or organization to another". In this study, knowledge sharing refers to the ongoing transfer of knowledge with external partner companies.

According to (Ernst & Kim, 2002), knowledge transfer will not happen automatically, it takes a knowledge sharing system in a complex process to internalize the knowledge that is disseminated. Knowledge sharing is one of the most important processes of knowledge management (Du et al., 2007). From the understanding of knowledge sharing and empirical research that has been carried out by previous researchers, it is suspected that the role of knowledge sharing has a positive effect on innovation performance in the context of public sector organizations in Indonesia. Then the hypothesis raised is as follows:

Hypothesis 3: There is a positive relationship between knowledge sharing and innovation performance

Knowledge sharing, collaborative innovation capabilities, and innovation performance

Collaborative innovation capability can moderate knowledge sharing in driving the company's innovation performance. Although participating in collaborative innovation activities can give companies access to new knowledge and have the opportunity to share it, its effect on innovation performance depends on the extent to which companies can absorb and implement this new knowledge in their innovation activities. (C. Wang & Hu, 2020). This is supported by research conducted by Cassiman & Veugelers, (2006); Tether & Tajar, (2008); Dahlander & Gann, (2010) which states that sharing knowledge with partner organizations is important, but must be supported by internal capabilities to organize the knowledge gained to create the desired company innovation performance.

The interaction between collaborative innovation activities and collaborative innovation capabilities is very important in knowledge sharing between companies (Tamer Cavusgil et al., 2003; Blomqvist and Levy, 2006 in C. Wang & Hu, (2020). The higher the collaborative innovation activity and knowledge sharing, the more and wider the knowledge sources the company has, so the higher the collaborative innovation capability needed to transfer and utilize this knowledge to get higher innovation performance.

Companies with a level of collaborative innovation capability are also able to dynamically respond to environmental changes. This responsiveness is manifested by the ability of collaborating companies to quickly adapt and apply shared knowledge to innovate new features of their products and services (Blomqvist, Kirsimarja; Levy, 2006). From previous research, it is suspected that collaborative innovation capability can mediate the relationship between collaborative innovation activities and innovation performance, as well as mediate the relationship between knowledge sharing and innovation performance. Thus, the hypothesis raised in this study is as follows:

Hypothesis 4: The positive effect between knowledge sharing and innovation performance is stronger when the company has collaborative innovation capabilities

Collaborative innovation activities, collaborative innovation capabilities and innovation performance

Participating in collaborative innovation activities with other organizations can result in very valuable collaborative outcomes such as new products and new knowledge if done properly, since public sector collaboration will not always produce public innovation (Torfing, 2019). That's why organizations need to have the capacity to absorb the results of collaboration and integrate the results of these collaborations into the work processes carried out by their companies to enhance the desired innovation performance (Coff 1999 in Hernandez-Espallardo et al., 2018). Organizations that have collaborative innovation capabilities also have the ability to respond to environmental changes (C. Wang & Hu, 2020)

Each company has different ability to assimilate and replicate the new knowledge gained from their collaborative innovation activities, where this ability is referred to as "collaborative competence". The ability to collaborate with other companies is a very valuable capability, but one that is rarely owned. In this study, collaborative innovation capability is defined as the ability to cooperate with partner companies in the innovation process and how it affects innovation performance (C. Wang & Hu, 2020). In previous research, it was stated that the company's ability to cooperate with innovative collaboration partners will make the company able to increase the effectiveness of their innovation process, so as to improve their innovation performance (Soosay et al., 2008).

From the definition of collaborative innovation capability and empirical research that has been done by previous researchers, it is suspected that collaborative innovation capability will have a positive effect on innovation performance. So the hypothesis raised in this study is as follows:

Hypothesis 5: The positive effect between collaborative innovation activities and innovation performance is stronger when the company has collaborative innovation capabilities

3. Research Method

This research was conducted with quantitative methods and used a single cross-sectional research design, which means that the research was carried out simultaneously (Malhotra, 2010). This study examines 4 variables and 3 dimensions with a total of 31 indicators, consisting of 3 indicators of collaborative innovation activities, 4 indicators of innovative collaboration capability, 5 indicators of knowledge sharing Wang & Hu, (2020), and 19 innovation performance indicators (Aryanto et al., 2015). These variables were assessed using a 6-point Likert scale (1 = strongly disagree to 6 = strongly agree).

Due to the limited number of respondents, this study did not conduct a pre-test for the questionnaire. However, the questionnaire was sent to 5 Heads of Agricultural Research and Development Center as reviewers of the feasibility of this questionnaire, to ensure that respondents would understand the content of the questions asked. During the discussion about the contents of this questionnaire, the researcher

paraphrased several indicators so that all indicators were clearer, unambiguous, and comprehensive. The sample of this research are 48 Heads of Agricultural Research and Development Center. This questionnaire was distributed in May – August 2021 using Google Forms through the WhatsApp application. This study uses the SEM-PLS data collection method with SmartPLS3. The PLS SEM method has the advantage of measuring small samples. Two stages of PLS SEM analysis were carried out, namely structural model analysis and measurement model analysis to ensure that the research measurement model had met the requirements as a valid and reliable model.

4. Results and Discussion

Evaluation of the reflective outer model can be seen from convergent validity, reliability, and discriminant validity. Table 3 summarizes all the items for each construct that has met the convergent validity criterion (Loading Factor 0.5 and AVE >0.5) and reliability criterion (Cronbach's alpha >0.7 and Composite Reliability > 0.7) (Hair et al., 2014). Based on table 3, Collaborative Innovation Activities has the lowest CA of 0,603. Therefore, CA more than 0.5 is still acceptable (Goerge and Mallery, 2003). This research has sufficed the requirements of discriminant validity using the fornell-lakers (see table 2).

Table 1. Fornell-Lakers

	CIA	CIC	KS	IPI	IPS	IPT
Collaborative Innovation Activities (CIA)	0.746					
Collaborative Innovation Capability (CIC)	0.727	0.743				
Knowledge Sharing (KS)	0.567	0.642	0.722			
Internal Performance (IPI)	0.609	0.736	0.62	0.832		
Social Performance (IPS)	0.629	0.63	0.712	0.717	0.822	
Technical Performance (IPT)	0.621	0.716	0.631	0.661	0.723	0.768

Source: SmartPLS Output 2021 (authors)

Table 2. Measurement Model

Variable	Dimension	Items	Convergent Validity		Reability	
			LF ≥ 0,5	AVE ≥ 0,5	CA ≥ 0,7	CR ≥ 0,7
Collaborative Innovation Activities		CIA1	0,577	0,557	0,603	0,787
		CIA2	0,839			
		CIA3	0,797			
Collaborative Innovation Capability		CIC1	0,732	0,552	0,728	0,831
		CIC2	0,799			
		CIC3	0,768			
		CIC4	0,668			
Knowledge Sharing		KS1	0,574	0,521	0,763	0,841
		KS2	0,676			
		KS3	0,617			
		KS4	0,882			
		KS5	0,812			
Innovation Performance	Internal Performance	IP1	0,711	0,693	0,888	0,918
		IP2	0,702			
		IP3	0,715			
		IP4	0,708			
		IP5	0,811			
	Technical Performance	IP6	0,605	0,589	0,858	0,895
		IP7	0,745			
		IP8	0,837			
		IP9	0,74			
		IP10	0,635			
	Social Performance	IP11	0,736	0,676	0,838	0,892
		IP12	0,843			
		IP13	0,771			
		IP14	0,622			
		IP15	0,601			
	Commercial Performance	IP16	0,653	0,589	0,768	0,851
		IP17	0,746			
		IP18	0,639			
		IP19	0,526			

Source: SmartPLS Output 2021 (authors)

Table 3. Hypothesis Testing

	Hypothesis			Original Sample	T Statistics	P Value	Status
H1	Collaborative Innovation Activities →	Innovation Performance		0.208	2.065	0.039	Supported
H2	Collaborative Knowledge Sharing →	Innovation Performance		0.567	5.355	0	Supported
H3	Knowledge Sharing →	Innovation Performance		0.357	2.443	0.015	Supported
H4	Knowledge Sharing →	Innovation Performance	*Collaborative Innovation Capability →	0.155	0.921	0.358	Not Supported
H5	Collaborative Innovation Activities →	Innovation Performance	* Collaborative Innovation Capability →	0.002	0.013	0.989	Not Supported

Source: SmartPLS Output 2021 (authors)

Hypothesis Testing

The effect of collaborative innovation activities on improving innovation performance is significantly positive. Table 3 shows the t-statistics value $2.065 > 1.96$, p-value $0.039 \leq 0.05$, and the original sample value 0.208 (positive). Hypothesis 1 is supported. In other words, joining in innovative collaborative activities with external partners, is one of the important factors that determine the success of the innovation performance of the organization. This is in line with research conducted by Wang & Hu, (2020). In this study, the two highest loading factor values in collaborative innovation activities are CIA2 (0.839) which relates to the frequency of collaborative research and development of new products and CIA3 (0.797) which relates to providing technical support to partner agencies in the process of collaborative research and development of new products.

This study indicates that collaborative innovation activity is significantly positive on improving knowledge sharing. Hypothesis 2 is supported, which showed on Table 3 that the t-statistics value 5.355, p-value 0 and the original sample value 0.567 (positive).

Knowledge sharing positively affects innovation performance. Hypothesis 3 is supported. Table 3 shows t-statistic value (2.443) and p-value (0.015), and the original sample value (0.357). In this case, the higher knowledge sharing is done by the organization, the better the innovation performance. This study supports research by Wang & Hu, (2020), which give positive result between knowledge sharing and innovation performance.

Hypothesis 4 in this study states that the positive influence between knowledge sharing and innovation performance is stronger when the company has collaborative innovation capabilities. Table 3 shows t-statistics value 0.921, p-value 0.358, and the original sample value 0.155 means that Hypothesis 4 is not supported. The effect of knowledge sharing on innovation performance does not only depend on the innovation capability of the company. This study supports previous research by Wang & Hu, (2020).

The effect of collaborative innovation capability on improving the effect of collaborative innovation activity is not significantly positive. Table 3 shows the t-statistics 0.013, p-value 0.939 and original sample 0.002. Hypothesis 5 is not supported. In other words, innovative collaboration capability is not the only factor that determines the success of a company's innovation performance. This study contradicts with Wang & Hu, (2020), that collaborative innovation capabilities can strengthen the influence of collaborative innovation activities on innovation performance.

5. Conclusion and Implication

This study enriches the idea that the relationship between collaborative innovation, collaborative innovation capability, knowledge sharing and innovation performance is a relationship that is more complex than a simple direct effect relationship.

It was found that the more public sector organizations involved in collaborative innovation activities with various partner companies, the more they were able to improve their innovation performance. Because by being involved in collaborative collaborative projects, companies are able to form information channels that can reduce time, effort, and other investments that must be spent to obtain information (Hildreth & Kimble, 2004).

Not all organizations are willing to share their knowledge with other organizations, whereas in order to

improve innovation performance, public sector organizations must obtain knowledge from external organizations. Whereas by being more involved in collaborative innovation activities, the joining organizations will consider each other as a very important strategic partner, because they are considered to have knowledge about each other's resources and innovation capabilities (Slowinski et al., 2015). That is, it is able to encourage the organization's desire to share knowledge, gain learning, and reach out to various disciplines to develop new technologies, products and services. Collaborative innovation activities are an ideal medium for sharing knowledge and learning with external partners (Cao & Zhang, 2011). The managers should realize that considering to share things with collaborators is important to achieve the full potential coming from engaging in collaborative innovation activities.

In this study, we suggest that it is important for public organizations to be more involved in innovative collaborative activities so that they can acquire external knowledge, which in turn is able to improve their innovation performance.

Collaborative innovation capabilities determine how much the organization's ability to collaborate with external organizations. Companies that have collaborative innovation capabilities are not only able to assimilate and implement the resources and knowledge gained, but are also able to make the organization ready to integrate the innovation process during collaborative innovation projects to improve its innovation performance (Mishra & Shah, 2009).

However, in this study, collaborative innovation capabilities is not considered as a factor that can encourage the relationship between knowledge sharing and innovation performance, as well as the relationship between collaborative innovation activities and innovation performance. The limited number of respondents is one of the factors that makes these results inconsistent with previous studies such as Sheu et al., (2006); Wang & Hu, (2020).

The other logical reasons why collaborative innovation capability does not apply to public sectors, explained by qualitative research conducted by Bradley, (2020) which says that although many public organizations carry out innovative collaborative collaborations, the barriers that exist in the work system of public sector organizations such as rigid bureaucracy, can affect the collaborative innovation capabilities of public sector organizations (Bradley, 2020). From the explanation above, the implication for public sector organizations is, as we continue to face challenges that we have never seen before such as Covid-19 and technological changes, it is very important for public sector organizations to try new approaches regarding work systems and capability development.

6. Limitation and Further Research

Research on collaborative innovation activities, collaborative innovation capabilities, knowledge sharing, and innovation performance in the public sector is still very limited whereas the public sector has great potential for innovative collaboration. Researchers hope that the results of this study can encourage other studies related to the interaction between these variables with a larger number of samples and in a wider public sector context.

The results of this study provide several suggestions for further research: (1) This research only focuses on collaboration between public organizations. Further research can explore collaboration between public organizations with the private sector and universities (2) Further researchers can examine other variables/factors that can mediate and/or moderate the relationship between collaborative innovation activities and innovation performance; (3) Further research can use a mix method (combining quantitative and qualitative methods) through survey methods, and Focus Group Discussions (FGD) to obtain more comprehensive and in-depth research results related to the influence of collaborative innovation activities, knowledge sharing, and collaborative innovation capabilities on innovation performance.

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