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OPEN INNOVATION STRATEGIES AND SMES' PERFORMANCE: THE MEDIATING ROLE OF ECO-INNOVATION IN ENVIRONMENTAL UNCERTAINTY

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Abstract:
The current increasing topic around empirical study is environmental issues. Several previous studies examined how open innovation strategies could affect eco-innovation amid research debates about environmental conservation in corporate innovation. This study aims to prove the effect of open innovation strategies on creating eco-innovation to affect SMEs' sustainable competitive advantage and performance empirically. This study developed and empirically tested the mediating role of eco-innovation on sustainable competitive advantage and performance. A quantitative approach in testing the empirical research model was implemented. A total of 223 SMEs in the batik sector in Yogyakarta were examined. We used purposive sampling approach to select the research sample. The criteria used in the sampling is SMEs batik which has been operating for three years or more. The results revealed that open innovation strategies significantly positively affected eco-innovation while eco-innovation significantly positively affected competitive advantage and SMEs performance. Environmental uncertainty strengthened the eco-innovation relationship on competitive advantage, but not on the SMEs' performance.

Key words: *open innovation strategies, eco-innovation, competitive advantage, and SMEs' performance*

INTRODUCTION

Small and medium-sized enterprises (SMEs) contributes to economic development and increasing environmental sustainability, so they need proper management through increasing competitiveness and superior performance creation. However, SMEs also have limitations on market access [1], human resources, relational capital [2], and a low ability to innovate and create value-added products through business networks [3, 4]. It takes a solid capability and strategy for SMEs to achieve a sustainable competitive advantage amidst the current limitations and uncertainties in the environment.

In the last decade, SMEs have competed to create environmentally friendly products. Global warming has influenced the awareness of SMEs actors to care about environmental conservation and change [5]. SMEs survive and respond to changing customer tastes during environmental uncertainty by creating environmentally friendly products [6]. They can also make eco-innovation [7] and strengthen strategies through open innovation patterns [8] to improve performance.

An open innovation strategy is vital for SMEs in increasing their competitive advantage [9]. Open innovations outside and inside the company could boost growth and profitability. In addition, companies with sufficient absorption capacity can achieve financial sustainability through open innovation. Ratten [10] found that environmental advances and regional wine clusters helped wine enterprises succeed better internationally. Furthermore, due of the wine industry's importance in the global economy, environmental issues are essential.

The industrial sector and SMEs are growing faster and concerned about consumer behavior and accompanying consumption patterns and environmental sustainability and production systems that are not environmentally friendly. Several researchers have emphasized production processes oriented towards environmental awareness by utilizing environmentally friendly technologies [11]. Sev-

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eral studies have seen that SMEs' sustainability works effectively through eco-innovation [7], and policymakers encourage companies to practice eco-innovation [12, 13]. The eco-innovation issue also affects SMEs' strategy choices in maintaining business sustainability [14].

Currently, customers also have an awareness of green management practices developed by SMEs through their concern for preserving business, the natural environment, and start modifying the behavior of company stakeholders to address social, ethical, and environmental sustainability issues [15, 16]. Therefore, eco-innovation has emerged in developing SMEs strategies to achieve sustainability and market growth [17]. Juarez and Vergara [18] emphasized eco-innovation as part of the SMEs' strategy and the opportunity to achieve resilience in the future. Meanwhile, other researchers explained that many companies need to carry out open innovation, technological innovation, and absorption [19].

This research contributes two new findings to the previous studies. First, the findings have enriched the scientific understanding of open innovation strategies on creating eco-innovation to affect sustainable performance and competitive advantage in the SMEs sphere. Second, this study developed and examined the critical mediating eco-innovation's role on sustainable performance and competitive advantage in an uncertain environment. The concept was tested on SMEs batik in Bantul, Yogyakarta, Indonesia.

Yogyakarta is a center of batik made from natural ingredients. The batik industry in Yogyakarta has experienced rapid growth. After the reformation era, batik recognition by UNESCO began to grow in Indonesia. Indonesian batik export value also increased. In 2008, these products export value reached USD 32 million until 2012 to USD 278 million. In 2013, Indonesia's batik exports grew by 18.49%. Data from the Ministry of Industry showed that batik SMEs from 2011 to 2015 grew 14.7% from 41,623 units to 47,755 units. In 2011-2015. Workers in this sector also increased by 14.7%, from 173,829 to 199,444. Batik consumers from abroad have also increased, seen from batik exports, rising 14.7% from 2011 valued at Rp. 43.96 trillion to Rp. 50.44 trillion in 2015 [20].

LITERATUR REVIEW AND HYPHOTESES

Open Innovation strategy

Open innovation is essential for the company's development. It is an approach where knowledge sources and exchanges tend to be cross-organizational [21]. Open innovation can develop through inbound and outbound knowledge in achieving organizational competitiveness.

Organizations view their growing importance in building innovation strategies with the dynamics and complexity of the availability and transfer of organizational knowledge and resources to achieve maximum efficiency and sustainable performance [9, 22]. Huang et al. [23] explained that open innovation will achieve business growth by optimizing business ideas sourced from external factors. Organizations need to consider open innovation practices such as positioning, product life cycle, technology adoption, and added value through introducing new products [24]. Meanwhile, Chesbrough [25] explained that the critical factors to encourage open innovation include increased technology costs.

Information from external organizations will accelerate the company's internal innovation [26]. Yun et al. [27] explained that corporate culture as a driver of open innovation activities is essential. Having a solid network [28] and technology capability [29, 30, 31] also enhances open innovation in the company. Companies that focus on open innovation will impact improving the company's performance [32, 33, 34].

Eco-Innovation

Eco-innovation combines ecological, economic, and social aspects in the company's innovation activities [13]. The company seeks to integrate eco-innovation into its business strategy [35]. This concept used in various industries includes automotive [36, 37], wine [10], and various other industries [38]. The ability of a company to apply or embrace new products, processes or ideas, is referred to as eco-innovation capability, to simultaneously maximize environmental, positive economic outcomes [39], contributing to environmental degradation and sustainability goals [40].

Eco-innovation is same as environmental innovation and green innovation in achieving competitive advantage [10]. Companies need to use a more holistic approach in comprehending social change and the dynamics of an ever-changing environment [41]. Ghisetti et al. [42] revealed that environmentally friendly open innovation becomes an essential factor in improving company performance.

Research interest that focuses on environmental innovation in the industry in recent years has increased, emphasizing environmental sustainability practices [43]. The main focus of environmental issues is to reduce the negative role of human activities with environmental destruction and business sustainability. Eco-innovation focuses on creating new products or improving existing ones, and promoting environmental improvements in logistics processes [44]. Eco-innovation impacts sustainability development [45] and sustainable competitive advantage [46].

Environmental Uncertainty

Companies must develop the ability to adapt [47] and develop strategies to cope with environmental uncertainty [48]. The company's external environment is full of uncertainty. This environmental uncertainty makes it difficult for companies to predict [49] and anticipate the future [50]. Environmental uncertainty refers to conditions of uncertainty, the absence of unexpected patterns and changes from the environment around the company and related to changes in technology, consumer preferences, and actions taken by competitors [51]. Zhang et al. [52] explained that competition, product/process changes, and changes in customer needs are the primary sources of environmental uncertainty. Environmental uncertainty is a dynamic and unpredictable condition where changes occur rapidly in the dynamics of business competition [53].

An uncertain environment drives organizations to develop operational capacity and innovation with information technology support [54]. Wang et al. [55] mentioned that in uncertain environmental conditions where there is potential and ambiguity, and high risk, companies need to optimize strategies and achievements through collaboration. While Atuahene-Gima et al. [53] explained that environmental uncertainty makes companies reach completely uncertain and unpredictable conditions, resulting in changes in customer preferences and needs, production technology in the dynamics of business competition. Companies need to respond to conditions in an uncertain environment.

Open Innovation Strategy Impacts on Eco-Innovation

Srisathan et al. [56] explained that growing companies constantly strive to develop open innovation, design sustainability, and create a more innovative corporate culture. The company needs to be open to the surrounding environment. Open innovation always absorbs information and knowledge external to the company and increases innovation [26]. Since a company's external examination is frequently focused on customers and competitors, growth, profit, and other indicators of success can be influenced by factors outside the industry [57].

Companies allow access to external capabilities to develop their technology [58]. One factor is the demand for business sustainability through an environmental approach. Companies should strive to absorb all information and knowledge so that their companies can carry out eco-innovation. The company thinks that creating a better world is vital and will impact innovation in greener products [59]. Therefore, open innovation will increase eco-innovation.

The open innovation in this study was around the scope of SMEs. Small and medium enterprises (SMEs) in rapidly changing environmental conditions can adapt quickly to changes through collaboration with external resources [19]. SMEs can also readily explore new knowledge and promptly achieve innovation through organizational learning processes and explore innovation creation. Another study also found that the adaptation carried out by SMEs was through their strategic role in developing eco-innovation through an open innovation strategy [41].

Therefore, the researchers proposed the following hypothesis.

H1: Open innovation strategy can increase eco-innovation positively and significantly.

Eco-Innovation Impacts on Companies Excellence

In most economies around the world, small and medium-sized businesses (SMEs) play an essential role [18]. SMEs seek technology-based competitiveness and increase their capabilities in innovation activities to survive. Open innovation is their preferred strategy in achieving organizational goals.

Eco-innovation refers to innovations that reduce pollution from the company's operational activities on the environment and the company's potential to utilize environmentally friendly raw materials [60]. Using a sample of 54 Italian industrial clusters, Daddi et al. [61] investigated the impact of eco-innovation on competitiveness. The results found a strong influence between eco-innovation on competitiveness.

Ratten [62] investigated the significance of eco-innovation in the Barossa Valley wine region's competitiveness, which is one of Australia's best wine areas. The results found that environmental innovation and wine clusters affected performance and increased competitiveness in the global economy. Companies must maintain a competitive advantage [63]. Companies must strengthen their product lines to survive in a competitive market by creating green innovations in a rapid and unavoidable change [43].

Nandakumar et al. [64] explained that companies could achieve competitive advantage through adaptation to the environment and competitive dynamics. Companies can adapt to environmental conditions, are accessible in operational cost efficiency, and create excellence. At the same time, Jamsa et al. [4] stated that the ability of SMEs to create environmentally friendly products is also impacted by their networks and internal capacities.

Therefore, the researchers proposed the following hypothesist:

H2: Eco-innovation has a positive effect on the sustainable competitive advantage of SMEs.

Eco-Innovation Impacts on SMEs Performance

Eco-innovation changes rapidly in environmental conditions. Several studies are currently still providing debate in the literature in defining eco-innovation with an analysis of internal factors that allow companies to increase competitiveness when investing in eco-innovation [65]. Furthermore, when a corporation invests in eco-innovation, the study discovered a positive relationship between financial performance and resource investment.

Cheng et al. [66] examined eco-innovation impacts on the business performance of various innovations linked to environmental associations in Taiwan. The results showed a strong impact of eco-innovation on business performance. In addition, environmentally friendly process innovation and environmentally friendly product innovation mediate the impacts of eco-innovation on business performance. Furthermore, eco-innovation consists of external and internal eco-innovation. External eco-innovation includes the company's external activities on green and sustainable activities, such as suppliers, regulators, and market demand. Meanwhile, internal eco-innovation relates to practices to manage the eco-innovation process effectively and efficiently in organizations, including organizational management.

Dong et al. [67] revealed that various eco-innovation approaches significantly influenced performance and competitiveness. However, this effect depends on company size and has a different and positive impact on environmental performance and competitiveness. In addition, the policy of creating environmental regulations causes a significant effect on performance and competitiveness.

Studi Alos-Simo et al. [68] tested 2094 companies and analyzed the company's earnings when implementing environmental innovations. The results revealed that eco-innovation positively affected income in all analyzed sectors and confirms the technological differences among enterprise

sectors. Eco-innovation also had a positive and significant effect on business volume. Therefore, the researchers proposed the following hypothesis.

H3: Eco-innovation has a positive effect on SMEs' performance.

Environmental Uncertainty as Moderator

Eco-innovation can improve performance [30, 32, 69] and competitiveness [10]. It allows companies to assess their environmental performance and continually improve it [70]. However, the role of environmental uncertainty is critical to increasing the impact of eco-innovation and performance. Several studies explained that environmental uncertainty moderated various relationships/influences between variables [48, 71, 72].

Many companies' success depends on how well they respond to changes in the external macro-environment, e.g., macro social, economic, technological, or political/regulatory [73]. Environmental uncertainty in environmental management is associated with inadequate expert knowledge of green technologies and an inability to make accurate predictions about green market demand [21]. The more companies can respond to environmental uncertainty; the more impact eco-innovation will increase its impact on company performance and competitive advantage. Tsai and Yang [74] investigated the role of the innovation strategy developed by the company in promoting performance improvement in a dynamic environment. Furthermore, the more vibrant the organizational environment is, the more innovation will impact growth. Conversely, low innovation performance will make the company's condition stagnant. Several other studies have found a strong influence between performance achieved in conditions of an uncertain business environment [49, 75, 76].

The dynamics of a changing environment and technological turbulence impact the adaptability of SMEs in responding to change [77]. An intense competition requires increasing capabilities during an uncertain environment that will influence the innovation and growth of small-scale companies [78]. SMEs need to improve their innovation and competitiveness in the turbulent and dynamic competitive environment. In contrast, Tsai and Yang [74] found that innovation would be easy to achieve in high market turbulence and intense competition. Therefore, the researchers proposed the following hypotheses.

H4: Environmental uncertainly can moderate the impact of eco-innovation on competitive advantage.

H5: Environmental uncertainly can moderate the impact of eco-innovation on performance.

Based on previous research studies and literature reviews, an empirical research model is built as follows:

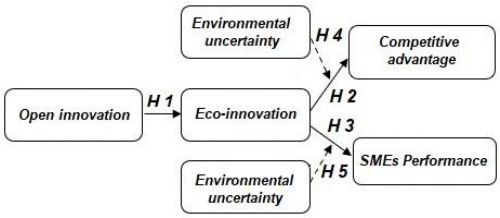


Fig. 1 Empirical research
Source: [8, 9, 78].

METHODOLOGY

Sample design and data collection

The sample of this research is batik SMEs owners in Yogyakarta, Indonesia. Batik SME uses natural resources in its production and is developing a production system that is environmentally sustainable. A quantitative approach empirically tested the open innovation strategy's effect on eco-innovation, sustainable competitive advantage, and SMEs' performance. This study also studied the mediating role of environmental uncertainty between eco-innovation and sustainable competitive advantage and SMEs' performance. In contrast, the sample in this study was taken by purposive sampling by considering the approach to the production process of SMEs Batik and environmentally friendly materials in the process.

To achieve the research objectives, data were collected from SMEs batik owners. We used purposive sampling approach to select the research sample. The criteria used in the sampling is SMEs batik which has been operating for three years or more. Sampling was based on the distribution of batik SME centers in the Yogyakarta area. This study was distributed to 223 batik SME owners in Yogyakarta, Indonesia. However, only 202 respondents completed and filled out the research instrument. Meanwhile, the unit of analysis chosen was the owner or manager of batik SMEs. The data collecting process was done by distributing questionnaires directly to respondents. After collecting the data, then the researchers continued testing the research hypothesis.

Development construct and measurement

As a first step for analyzing the reliability and validity of the measurement scale used in this study, the measurement scale of the four constructs was determined by conducting a literature review on previous studies. It was prepared by referring to earlier studies with inbound and outbound innovation [79]. Eco-innovation with indicators on product eco-innovation and process eco-innovation referred to [36]. Sustainable competitive advantage referred to [80], and SMEs performance referred to [81]. Environmental uncertainty referred to previous studies with environmental activities indicators to reduce cost and lead time and improve product quality and reputation [82]. The construct of open innovation, eco-innovation, sustainable competitive advantage, SMEs' performance, and environmental uncertainty was measured by four items. A five-point Likert-type scale was used to establish a balance between respondents' constructs and analysis accuracy. In this study we use a five-point Likert-type scale researcher. The questionnaire was designed to measure the constructs using 1-5 Likert-type scale on the respondents' answers [83]. Score 1 represented the most Likert-type scale very disagreed answer and Score 5 represented the most very agre answer.

Validity and Reliability Testing

This study measured the validity with Confirmatory Factor Analysis (CFA) seen from the loading factor value. Reliability testing was conducted by looking at Cronbach's Alpha value

with a standard calculation result of a value above 0.70. The results of each indicator in each construct are explained in Table 1.

Table 1
Validity and Reliability Measure of Variable

Construct	Indicator	Factorial Loading	Cronbach's Alpha	Composite Reliability	AVE
Open innovation	OIS1 OIS2 OIS3 OIS4	0.828 0.764 0.817 0.709	0.861	0.907	0.561
Eco-innovation	ECI1 ECI2 ECI3 ECI4	0.743 0.740 0.700 0.721	0.837	0.894	0.579
Sustainable competitive advantage	SCA1 SCA2 SCA3 SCA4	0.821 0.763 0.771 0.723	0.852	0.905	0.565
SMEs performance	SMP1 SMP2 SMP3 SMP4	0.785 0.789 0.809 0.806	0.876	0.910	0.556
Environmental uncertainty	ENU1 ENU1 ENU1 ENU1	0.764 0.687 0.704 0.616	0.851	0.888	0.586

RESULT

Hypothesis testing implemented the AMOS program as an empirical equation model test. The theoretical model's validity on the constructs of open innovation strategy, eco-innovation, sustainable competitive advantage, SMEs' performance, and environmental uncertainty was through tests by comparing the results obtained between the theoretical model and the measurement model.

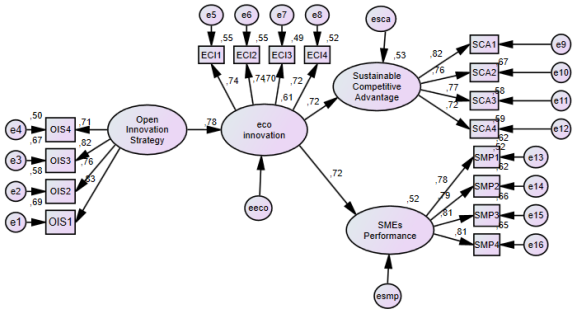
In this study, the insignificant results obtained allowed an explanation of the observed relationship in the latent construct [84]. Table 2 presents the results obtained from SEM testing on the four constructs. While the model suitability test used several calculated criteria, including goodness-of-fit index (GFI), x2/df, normed fit index (NFI), adjusted goodness-of-fit index (AGFI), comparative fit index (CFI), and the root mean square of approximation (RMSEA). The overall size of the SEM in this study revealed that the model suitability test had good results, as shown in Figure 2.

Table 2
Model fit test

	x^2/df	GFI	AGFI	NFI	CFI	RMSEA
Structure model	1.578	0.896	0.860	0.899	0.960	0.058
Recommended value	< 3	> 0.9	> 0.8	> 0.9	> 0.9	< 0.1

Figure 2 and Table 3 reveal that all paths estimated in this study are significant.

The test on H1 shows the impact of open innovation strategy on eco-innovation (β = 0.542, p = 0.000 < 0.05). H1 reveals that the open innovation strategy has a significant positive effect on eco-innovation. Thus, H1 is supported.



Chi-square=159,335;Probability=,000;DF=101;CMIN/DF=1,578;GFI=,896;AGFI=,860;CFI=,960;TLI=,952;RMSEA=,058

Fig. 2 The results of the full model

The test on H2 shows a significant positive effect between eco-innovation on competitive advantage (β = 0.369, p < 0.05). Thus, H2 is supported. The test on H3 shows a significant positive effect of eco-innovation on SMEs performance (β = 0.386, p < 0.05). Thus, H3 was supported. Testing on the moderating effect of environmental uncertainty on the relationship between eco-innovation and competitive advantage shows the value of (β = 0.345, p = 0.002 > 0.05). Thus, H4 is supported. Meanwhile, the moderating role of environmental uncertainty on the relationship between eco-innovation and SMEs' performance shows the value of (β = 0.027, p = 0.713 > 0.05). Thus, H5 is rejected.

Table 3 shows the results of testing each research hypothesis from H1 to H5.

Meanwhile, the interaction moderating test between environmental uncertainty on the relationship between eco-innovation on competitive advantage and SMEs' performance are presented in Figure 3.

Table 3
The results of hypothesis testing

Hypothesis	Structural relationship	β	*p-value*	Supported
H1	Open innovation strategy → eco-innovation	0.542	0.000	*H1* is supported
H2	eco-innovation → sustainable competitive advantage	0.369 0.525	0.000 0.000	*H2* is supported
H3	eco-innovation → SMEs performance	0.386	0.000	*H3* is supported
H4	Interaction moderating 1	0.345	0.002	*H4* is supported
H5	Interaction moderating 2	0.027	0.713	*H5* is rejected

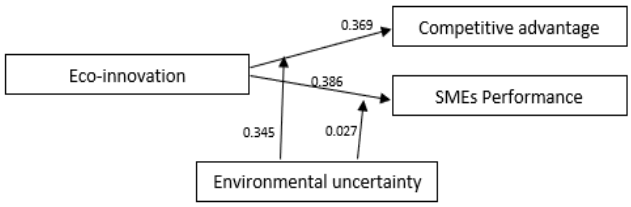


Fig. 3 Moderation effect testing

COCLUSIONS

The results of empirical testing found that the first to fourth hypotheses tested were positively significant. At the same time, the fifth hypothesis testing showed insignificant results. The results indicate that empirically the previous studies in testing this construct did not all support the findings.

The results of this study were tested empirically research with batik SMEs scope, where this industry has developed an eco-innovation strategy in the environmental uncertainty condition. This study is specifically limited to the scope of batik SMEs. Moreover, the competition in the scope of SMEs is currently very tight amid environmental uncertainty. The sample in this study was very limited to batik SMEs.

The study is an empirical testing conducted scope of research sample of SMEs business in an effort to investigate and measures of open innovation strategy construct and eco-innovation and examine the effect on competitive advantage and performance of SMEs. The empirical research model are developed through of research designs and measurement scales that are designed during the data collection process and research instruments through measuring validity and reliability. The final instrument listed in this study can be seen in Table 2. Further testing was carried out to measure the validity of the instrument through construct reliability testing which was developed in the research instrument so that it could be used in future research.

The results of this study indicate that open innovation strategies has a positive, direct, and statistically significant effect on eco-innovation. This study also explain that eco-innovation has a positive, direct, and statistically significant effect on competitive advantage and SMEs performance. Environmental uncertainty has a strengthened the relationship between eco-innovation on competitive advantage, but not significant effect on SMEs' performance.

DISCUSSION

The first hypothesis proved that open innovation had a significant positive effect on eco-innovation. This result aligns with previous research that companies could utilize external knowledge to increase innovation [26]. Other previous studies also found that adaptations made by companies include their strategic role in developing eco-innovation through open innovation strategies [41]. The second and third hypotheses revealed that eco-innovation had a significant positive effect on competitive advantage and performance. The results are similar to previous studies where eco-innovation could increase the competitiveness of companies [61]. Previous findings also discovered a strong influence between eco-innovation on competitiveness [62]. Cheng et al. [66] supported the conclusion that eco-innovation affected performance. Dong et al. [67] also found that eco-innovation encourages performance and competitiveness.

This study discovered that environmental uncertainty strengthened the relationship between competitive advantage and eco-innovation. Meidute-Kavaliauskiene et al. [21] had similar findings that the more companies respond to environmental uncertainty, the more eco-innovation will increase their competitive advantage and company performance. Other studies also supported the conclusion that innovation strategies encourage improved performance in a dynamic environment [74].

Managerial Implication and Limitation

This study proved the purpose of research on eco-innovation mediation between open innovation strategy on SMEs' performance and competitive advantage. The researchers also examined the moderating effect of environmental uncertainty on the relationship between eco-innovation and SMEs' competitive advantage and performance empirically.

The open innovation strategies concept is crucial for SMEs in developing innovation by adopting ideas from external companies. Therefore, this study also offers a solution to "eco-innovation" and emphasizes that open innovation strategy and eco-innovation are essential keys to increasing SMEs' competitive advantage and performance amidst environmental uncertainty and preservation issues.

This study conducted an in-depth review of the previous literature on open innovation strategy and eco-innovation and their impact on competitive advantage and performance.

This research observed the batik SMEs environment in Yogyakarta, Indonesia, and had limited samples with different characteristics in developing environmentally friendly products. Educational background was still low according to the result. Thus, some questionnaires were not complete in the distribution process. This study recommends further research considering the limitations of the research sample also to take samples from other locations to represent good results. In addition, the results of model testing found problematic data in testing data normality and outliers, thus helping researchers to need to have accuracy in research.

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