Controlling Forest and Land Fires in Riau Province using Collaborative Governance: Support for Smart Environment

Dita Fisdian Adni[1]*

[1] Department of Islamic Politics–Political Science, Universitas Muhammadiyah Yogyakarta, Bantul; Universitas Islam Riau, Pekanbaru, Indonesia

Abstract. Riau Province is one of the provinces with the largest areas of forest and land fires in Indonesia. Therefore, a collaboration between agencies is needed, both government agencies and non-government organizations at the national, provincial and district/city levels, to control forest and land fires. This research aims to explore forest and land fire control in Riau Province using collaborative governance. This quantitative research is analyzed with structural equation modeling (SEM) techniques using SmartPLS to analyze data and test hypotheses. Data were obtained from 150 questionnaires distributed to multi-actors consisting of five (5) organizations involved in collaborative land and forest fire control in Riau Province. The results showed that controlling forest and land fires in Riau Province can be done using collaborative governance. This is evidenced by the hypothesis results, where culture significantly influences trust in collaboration. Furthermore, trust also has a positive effect on the output of collaboration, and output also affects the outcome of collaboration. However, facilitating leadership and institutional design does not significantly impact trust in collaboration to control forest and land fires in Riau Province. The collaborative governance model by Ansell and Gash was developed by adding culture and output indicators. In addition, this research also considers the application of a smart environment in discussing collaborative governance to support environmental sustainability in the future.

Keywords : adoption of collaborative governance, smart environment, forest and land fires, environmental sustainability

1 Introduction

Forest fires are caused either naturally or by man. Only 20% of forest and land fires occur naturally, while most other fires are caused by human actions [1]. Human actions that cause forest and land fires include the habit of people who clear land by burning, which is even worse than the clearing and clearing of forests and land carried out by plantation companies

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* Corresponding author: ditafisdianadni@soc.uir.ac.id

[2].Riau Province is one of six provinces in Indonesia besides Jambi, South Sumatra, West Kalimantan, Central Kalimantan, and South Kalimantan Provinces worst affected by fires in 2016 [3]. Riau Province has a large area of forest and land fires and is located in a peatland area prone to fire [4]. The total area of fires in Riau Province is reported to be around 90,709 km2, which is about 19.02% of the total fire area on Sumatra Island [5].

Many efforts have been made to control forest and land fires [6]. Several attempts were made to incorporate elements of technology in controlling forest and land fires [7]. The technology used includes weather modification technology, a human intervention in forming rain in clouds [8]. In addition, another form of technology is a Web-based dissemination system of Geographic Information Systems with the Geonode application, where this system is used to facilitate the dissemination of information on the distribution of hotspots [9].

Regardless of the use of technology in controlling it, forest and land fires are a problem that requires cooperation or collaboration from various institutions, both at the national, provincial, and district/city levels. The involvement of these institutions requires an organizational system that works in an integrated and harmonious manner so that it is effective and efficient [10]. Controlling forest and land fires in Riau Province involves many institutions, such as the central government, regional governments, non-governmental organizations, and other professional parties [11].

This shows that involving many human resources must be well coordinated so that sectoral differences and ego in collaborating institutions do not become an obstacle in controlling forest and land fires [12]. Researchers developed a collaborative governance model by Ansell and Gash (2008) to test hypotheses related to forest and land fire control in Riau Province by using collaborative governance by adding cultural and output indicators.

2 Method

Data was collected by distributing questionnaires to actors controlling forest and land fires in Riau Province. A population sample was drawn using the Slovin formula with one hundred and fifty (150) people. In addition, interviews were also conducted to find out how to control forest and land fires in Riau Province using collaborative governance. The collected data were analyzed using structural equation modeling (SEM) techniques and measurement models through statistical tools, namely SmartPLS, to analyze data and test hypotheses. Measurement models are used to test validity and reliability, while structural models are used to test quality and hypotheses.

Table 1. Population and Samples

	Population	*Sample*
The Riau Province Environment and Forestry Service	45	40
The Riau Province Disaster Management Agency	35	33
The Riau Regional Police	32	30
the Military Resort Command 031 Wira Bima	30	28
Wahana Lingkungan Hidup (WALHI)	20	19
	162	150

Source: processed from primary data in 2021

3 Literature Review

The concept of governance has developed over time [13]. There are several variants in the concept of governance which include good governance [14], network government [15],

partnership governance [16], new public governance [17], sound governance [18], to collaborative governance. Conceptually, collaborative governance studies highlight the characteristics of cooperation among the three pillars, namely government, private sector, and society [19].

For more than two decades, collaborative governance has attracted the attention of academics and practitioners in various disciplines [20]–[22]. According to Klijn and Koppenjan, in practice, collaborative governance requires complex interactions between a large number of actors who are interdependent on one another. However, this interaction is more complex and spontaneous, requiring management and network constitution to achieve a certain degree of success [23].

Collaborative governance is a concept that is often used to address various public problems in several fields, such as the problem of disaster mitigation [24], food security [25], prostitution and human trafficking [26] and countermeasures Covid 19 [27]. Likewise, issues regarding forest and land fires can be controlled using the concept of collaborative governance [28].

Forest and land fires cause several adverse effects, the first of which is haze which threatens public health due to acute respiratory infections, destroys plant vegetation and natural resources, closes offices and schools, and incurs substantial firefighting and rebuilding costs [29]–[31]. Systematic and orderly management of forest and land fires is required to control forests and land fires successfully [32].

According to Wirawan, curative efforts to control forest and land fires have been considered ineffective and wasteful and have not provided a deterrent effect [33]. Seeing the ineffectiveness of efforts to control forest and land fires, the President issued Presidential Instruction Number 11 of 2015 concerning Strengthening Forest and Land Fire Control, renewed in 2020 in Presidential Instruction Number 3 of 2020.

The Presidential Instruction emphasizes strengthening control through multi-sectoral collaboration and instructs Regional Heads, as administrators of government affairs in the forestry sector, to compile regional regulations regarding the system for controlling forest and land fires [34]. However, even though regulations and laws related to forest and land fires have been issued, these incidents continue to recur [35].

3.1 Culture in Collaborative Governance

The result of the collaboration is networking and purpose. The formation of networks will form a collaborative process [15]. The network formed from the collaboration will develop an organizational culture that will further affect the sustainability of the collaboration [36], as stated by Djumara [37] who described that one of the components of collaboration is Collaborative Culture. Meanwhile, according to Schein, culture is the attitude, behavior, habits, and values that determine how the organization works [38].

H-1: Culture influences Collaborative Process, which is focused on trust.

3.2 Trust-Building

Some literature states that the collaboration process is about negotiation and building trust among stakeholders [39]–[42]. It was found that building trust is often the most salient aspect early in the collaboration process and is difficult to grow [43].

H-2: Trust affects the output of collaboration.

3.3 Facilitative Leadership

The literature finds that facilitative Leadership is important to bring stakeholders together and engage them in a collaborative spirit [44]. Lasker and Weiss argue that the facilitative leader should "give participants a meaningful voice" and encourage participants to listen to one another. Leaders must stimulate creativity by "synthesizing the knowledge of diverse participants so that the group can generate new ideas and insights" [45].

H-3: Facilitate Leadership has a significant influence on trust.

3.4 Institutional Design

Institutional design refers to basic rules and procedures and transparency in the collaboration process [19]. Institutional designs are agreed-upon rules based on consensus among stakeholders [46]. In collaborative governance, consensus is seen as a way to promote the representation of individual viewpoints and encourage cooperation [47]. However, consensus rules are often criticized for leading to "most unequal" results [48].

H-4: Institutional Design has a significant influence on trust.

3.5 Output and Outcome in Collaborative Governance

One of the core questions regarding the performance of collaborative governance is the extent to which they produce outputs and outcomes. Does it provide benefits to society [49]? Collaboration contributes to outcomes, for example, facilitating planning and policy development and increasing the effectiveness and efficiency of that collaboration [50] by spurring innovation and novelty [51], [52] or enhancing the delivery of services that effective [53], [54].

H-5: The collaboration output produces outcomes through policies, controlled forest fires and forest restoration.
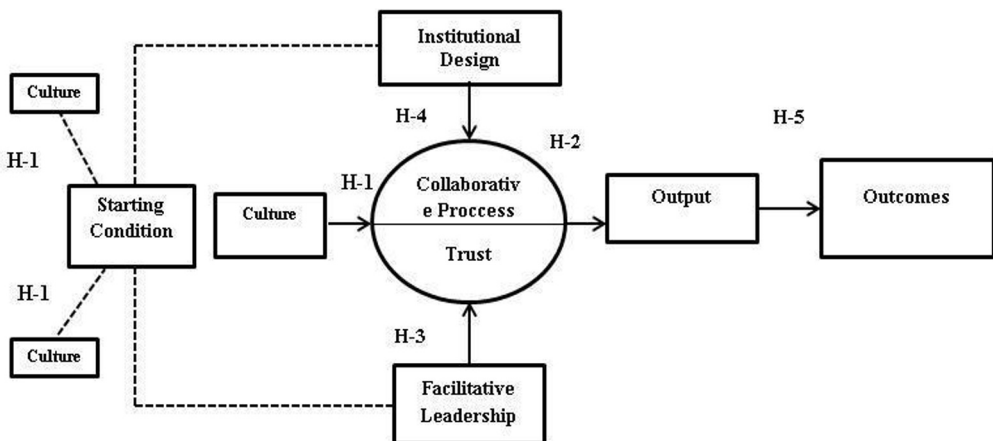

Fig. 1. Conceptual Framework

4   Findings and Discussion

4.1 Structural Model Validity test

The first and second criteria, namely Convergent and Discriminant Validities, can be seen from the results of the outer model value, namely the AVE value. The validity of AVE data has a limit value and is valid or invalid if the value is above or below 0.50. Data validity seen from cross-loading also has a valid limit value. The cross-loading value is said to be valid and invalid if the cross-loading value is above or below 0.50, respectively.

Table 2. Validity Test

Variables	Indicators (Questionnaire Question)	Loading Factor	AVE	Des
Culture	Cul 1	0.844		Valid
	Cul 2	0.864		Valid
	Cul 3	0.874		Valid
	Cul 4	0.899	0.688	Valid
	Cul 5	0.849		Valid
	Cul 6	0.833		Valid
	Cul 7	0.746		Valid
	Cul 8	0.711		Valid
Trust	Tr 1	0.863		Valid
	Tr 2	0.804		Valid
	Tr 3	0.875		Valid
	Tr 4	0.836	0.686	Valid
	Tr 5	0.855		Valid
	Tr 6	0.819		Valid
	Tr 7	0.789		Valid
	Tr 8	0.779		Valid
Facilitate Leadership	FL 1	0.759		Valid
	FL 2	0.749		Valid
	FL 3	0.830		Valid
	FL 4	0.737	0.637	Valid
	FL 5	0.790		Valid
	FL 6	0.830		Valid
	FL 7	0.831		Valid
	FL 8	0.848		Valid
Institutional Design	ID 1	0.557		Valid
	ID 2	0.909		Valid
	ID 3	0.807		Valid
	ID 4	0.579	0.534	Valid
	ID 5	0.597		Valid
	ID 6	0.905		Valid
	ID 7	0.597		Valid
	ID 8	0.787		Valid
Output	OP 1	0.804		Valid
	OP 2	0.811	0.525	Valid
	OP 3	0.798		Valid
	OP 4	0.823		Valid

	OP 5	0.714		Valid
	OP 6	0.563		Valid
	OP 7	0.672		Valid
	OP 8	0.549		Valid
Outcome	OC 1	0.835		Valid
	OC 2	0.821		Valid
	OC 3	0.819		Valid
	OC 4	0.837	0.605	Valid
	OC 5	0.819		Valid
	OC 6	0.818		Valid
	OC 7	0.651		Valid
	OC 8	0.573		Valid

The results of the validity test in Table 1 show that all questions in each research variable consisting of culture, trust, facilitating leadership, institutional design, output and outcome have a loading factor value above 0.500. Therefore, all questions in all the research variables above are valid or meet convergent validity.

4.2 Reability Test

Reliability is an index that shows how much a measuring instrument can be trusted or relied upon. This study uses composite reliability to test variables. According to research, the Rule of thumb, the alpha or Composite reliability value must be greater than 0.7, although 0.6 is still acceptable.

Tabel 3. Composite Reliability dan Cronbachsalpha

Variables	Cronbach's Alpha	rho_A	Composite Reability	Average Variance Extracted (AVE)	Ket
Culture	0.935	0.939	0.946	0.688	Realible
Facilitate Leadership	0.934	0.737	0.933	0.637	Realible
Institutional Design	0.932	0.925	0.898	0.534	Realible
Outcome	0.944	0.909	0.923	0.605	Realible
Output	0.866	0.868	0.896	0.525	Realible
Trust	0.903	0.937	0.946	0.686	Realible

Based on the output of composite reliability and Cronbach alpha in Table 3 above, each construct's value is above 0.70. The culture variable has Composite Reliability and Cronbach's Alpha values, namely 0.935 and 0.946. Meanwhile, the trust variable has Composite Reliability and Cronbach's Alpha values of 0.934 and 0.946. Furthermore, Facilitate Leadership has Composite Reliability and Cronbach's Alpha values of 0.930 and 0.936. Furthermore, the institutional design variable has Composite Reliability and Cronbach's Alpha values of 0.944 and 0.898.

The Output variable has Composite Reliability and Cronbach's Alpha values of 0.866 and 0.896. Finally, the outcome variable has Composite Reliability and Cronbach's Alpha values of 0.903 and 0.923. Based on the explanation above, the value or output of composite reliability and Cronbach alpha in the table above shows that the value of each construct is

above 0.70. So it can be concluded that each construct in the estimated model has good reliability.

4.3 Regression Analysis

Regression testing was carried out to determine the relationship between constructs, significance value, and R-square of the research model.

Table 4. Regression Results

Variables	R Square
Outcome	0.696
Output	0.638
Trust	0.688

The table above shows the R-square values of forest and land fire control using collaborative governance on the outcome, output, and trust variables, respectively, 0.696, 0.638, and 0.688. Based on the table above, it can be concluded that forest and land fire control uses collaborative governance, the variables consisting of outcome and trust have a good level because the R-square value is greater than 0.670. At the same time, the output has a moderate level of influence because the R-square value is above 0.330.

4.4 Research Implication

Based on testing the model of the aggregate and comparative research results, this research proposes a theory of collaborative governance in controlling forest and land fires in Riau Province. Therefore, based on regression weighting, path coefficients, and testing the hypothesis on the relationship between variables, culture and output are determining factors that complement Ansell & Gash's collaborative governance theory. This relationship is shown in the figure and table below:
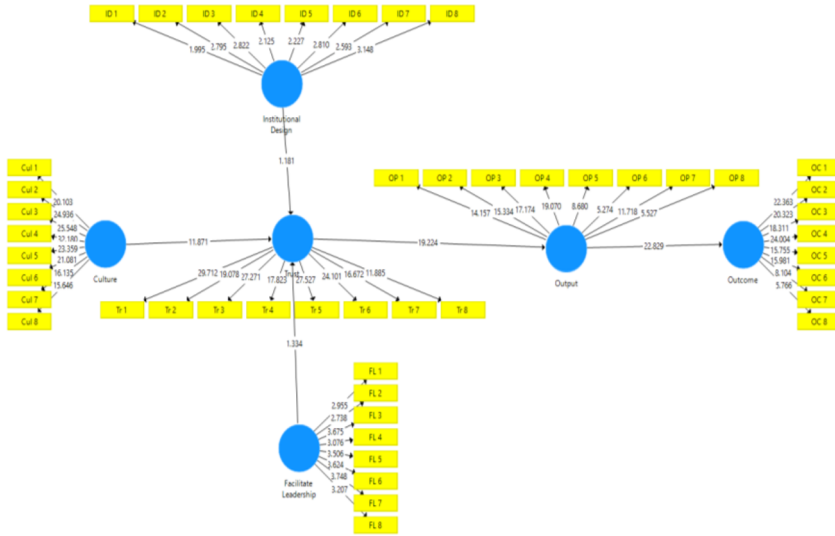
Fig. 2. Bootstrapping Output

Table 5. Hypothesis Test Results

Variabel	T Statistics	P Values	Penilaian Hipotesis
Culture -> Trust	11.871	0.000	Accepted
Facilitate Leadership -> Trust	1.334	0.183	Rejected
Institutional Design -> Trust	1.181	0.238	Rejected
Output -> Outcome	22.829	0.000	Accepted
Trust -> Output	19.224	0.000	Accepted

4.5 Discussion

Figure 2 and Table 5 above show the results of testing the hypothesis in this study. The hypothesis is accepted with the assumption that the T-statistic value in the figure is greater than 1.96 (<1.96). Therefore, based on the figure above, the variables that facilitate leadership and institutional design do not significantly influence trust in collaborative governance.

H1. Figure 2 and Table 5 show that culture positively and significantly influences trust in implementing collaborative governance in controlling forest and land fires in Riau Province. The culture maintained in collaboration in controlling forest and land fires is also the reason for the lack of collaboration because there is still dominance from the government, which needs to carry out agreements based on cooperation. This finding is similar to previous research that culture influences trust in collaboration positively and negatively [55].

H2. Figure 2 and Table 5 show that facilitating leadership has a negative and insignificant effect on trust. The leadership possessed by the forest and land fire control task force in Riau Province has yet to be able to foster trust among the institutions that join the task force. This finding is similar to another insignificant effect of facilitated leadership on trust in this study [56].

H3. Figure 2 and Table 5 show that institutional design has a negative and insignificant effect on trust. Overlapping institutional designs will affect the effectiveness of collaborative governance in controlling land and forest fires in Riau Province, making it impossible for trust to grow between the actors involved in the collaboration. These findings are similar because there is a significant relationship between institutional design influencing trust in implementing collaborative governance [57].

H4. Figure 2 and Table 5 show that the output positively or significantly influences the outcome. The intended output is the discovery of a coordinated and integrated pattern of controlling forest and land fires in Riau Province. Afterward, the outcome that will be realized is controlled forest and land fires that occur in Riau Province. This finding is supported by previous research conducted by [58], [59], which states that when the output is successfully realized, the outcome will immediately follow.

H5. Figure 2 and Table 4 show that trusts positively and significantly affects output. The growing trust between institutions collaborating on forest and land fires in Riau Province will certainly accelerate the achievement of medium or short-term output or results. This finding is similar to previous research that trust will influence collaboration output [60].

Trust, an important factor in this study, also has implications relevant to the smart environment concept. In a smart environment, trust between the various actors and institutions is essential for establishing effective cooperation and ensuring the successful implementation of smart solutions. Trust that grows between institutions, government, communities and other stakeholders will strengthen collaboration and coordination in controlling forest and land fires. With high trust, various parties will be more likely to share data and information, coordinate efforts to prevent and deal with fires and take sustainable actions to maintain environmental sustainability. In the context of a smart environment, building strong trust will support closer collaboration between people and technology and accelerate the adoption and implementation of smart solutions that can improve forest and land fire management.

5   Conclusion

This research aims to explore forest and land fire control in Riau Province by using collaborative governance through the development of Ansel & Gash's model. In this study, the authors added two variables, namely culture and output, followed by other variables, namely trust building, facilitating leadership, institutional design and outcomes. The results show that collaborative governance can be used in controlling forest and land fires in Riau Province, although the results could be more optimal. This can be proven by the results of the hypothesis, which shows that culture significantly influences trust in collaboration. Furthermore, trust also positively affects output, and output also influences the outcome of collaboration. However, facilitating leadership and institutional design have no significant effect on trust. Furthermore, collaboration results will be maximized if it is accompanied by technologies that can control or even prevent forest and land fires in Riau Province.

This research has strong relevance to the smart environment concept. The implementation of collaborative governance in controlling forest and land fires in Riau Province can be integrated with technology and the smart environment concept. For example, advanced technology such as fire sensors, remote sensing, and data analytics can detect forest and land fires early and monitor environmental conditions in real time. This needs to be considered in the future to overcome existing problems. With collaboration between various institutions and stakeholders in managing forest and land fires, the data and information collected can be used effectively to make the right decisions and coordinate efforts to deal with fires. In the context of a Smart Environment, technology-supported collaborative

governance can improve efficiency, accuracy and response speed in overcoming forest and land fires.

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