A Foresight in *Rimbawan* Performance Level: Toward A More Controllable Forest Fires Area

Anggi Dian Safitri Hasibuan[1], *Luluk* Setyaningsih[2], *Abdul* Rahman Rusli[2], *Kresno* Agus Hendarto[3], *Dian* Charity Hidayat[4] and *Tri* Astuti Wisudayati[4,*]

[1] Center for the Implementation of Standards for Environmental and Forestry Instruments in Bogor, Jl. Pakuan II Ciheuleut 105, Tegallega, Bogor Tengah, Bogor, West Java- Indonesia
[2] Nusa Bangsa University, Jl. K.H Sholeh Iskandar, Km 4, Tanah Sareal 16166, Bogor, West Jawa-Indonesia
[3] Research Center for Plant Conservation, Botanical Garden and Forestry, National Research and Innovation Agency, Jl. Ir. H. Juanda No. 13 Bogor, Jawa Barat, Indonesia
[4] Research Center for Cooperatives, Corporations, and the People's Economy, National Research and Innovation Agency, Jl. Gatot Subroto No 10 Jakarta 12710, Indonesia

Abstract. *Rimbawan* (foresters) is one of the human resources owned by the Ministry of Environment and Forestry. They need to enhance their performance in decreasing forest fire areas. It will affect future public health, economic development, ecological balance, social stability, and land aesthetics. Accordingly, scenario planning helps in contemplating how the future may develop and is especially important when needing to make sense of uncertainty in the forest sustainability management sector. Scenario planning can be narrative-based and represented quantitatively to ensure *Rimbawan's* performance level. On the other hand, promoting a more controllable forest fire area has not been fully anticipated. Therefore, this study aims to help environmental policymakers by offering a discovery of basic data for forest fire precautions, forest firefighting, and post-forest fire handling. This study has conducted a descriptively quantitative method. The results suggest that the average forest fire area in South Sumatra Province based on their KPH from 2015-to 2019 is 30.71 percent of those 2,265,457.34 hectares of KPH. Whereas the 1 level of an increase in forest fire prevention activities will reduce the probability of forest fire insight into the upscaled *Rimbawan's* performance level through conversation quality and engagement, learning, decision-making style, mental models, and leadership support.

* Corresponding author: triastutiwisudayati@gmail.com

1 Introduction

A forest fire has received considerable critical attention from environmental policymakers due to its effect on public health, economic development, ecological balance, social stability, and land aesthetics. It is a widely held view that a complete effort toward forest fire control or forest fire case elimination has been performed by "*Rimbawan*." To date, *Rimbawan* or foresters are one of the human resources owned by the MoEF (Ministry of Environment and Forestry). They tend to focus on prevention activities at the site level for forest preservation. There is a strong possibility that *Rimbawan* best performance practice will control forest fires. Studies have monitored the performance of foresters[1] and found the need for improved facilities that support their performance in forest protection. What is striking in [2] research is a very long-term struggle to control forest fire, which is: forest fire precautions step, forest firefighting steps, and post-forest fire handling steps. A following more positive effect on decision quality is essential to evaluate the feasibility and sustainability of a valuable strategy [3]. Thus, it is urgent to draw attention to integrated scenario planning [4] and expect it to be an approach to promoting coordinated development and management of *Rimbawan's* performance. However, how complex thinking of scenario planning in environmental research aid gains in scientific knowledge [5], engineering experience [6], and support for policymakers [7], to date this scenario of *Rimbawan's* performance is not well understood.

To better understand the current *Rimbawan* performance focus, studies across a comprehensive scenario planning conducted to emphasize the fast-growing forest fire issues are required. The evidence shows that there has been an increasingly popular tool in place-based environmental research for evaluating alternative futures of social-ecological systems [8,9]. Therefore, such related approaches to the research question and the main conclusions are urgently summarized for recommendations for forest sustainable management [10,11]. For the last decade, there have been limited reports in Indonesia evaluating *Rimbawan's* performance using a scenario planning strategy due to forest fire control at the scale of the forest fire case in South Sumatra Province. Most presented knowledge about early detection tools for forest fire [12], forest fire control, and implementation in the region [2], especially the study of inter-coordination institutions [13].

With a curiosity about the possible merits of the increase in *Rimbawan's* performance level on decreased the forest fires area, this research aims to help practitioners or environmental policymakers by offering a discovery of basis data for elaborating on *Rimbawan's* performance contribution toward forest fire precautions, forest firefighting, and post-forest fire handling. To reflect a growing future possibility in forest sustainability, its needs scenario planning analysis for upscaling *Rimbawan* performance.

2 Materials and Methods

2.1 Data collection and analysis

The research took place in the scenario dimension of a written questionnaire, which was responded to by 81 *Rimbawan* in the KPH (*Kesatuan Pengelolaan Hutan*) area in South Sumatra Province. Questionnaires have been used in the last February of 2021 to investigate the respondent's level of performance on a symmetric agree-disagree scale for a series of statements. The research conceptual framework uses The Generic Scenario Planning Model (Figure 1). The use of qualitative case studies is an approach that can diagnose why some items did not work well and help to find common ground for future action, which in turn is the main essence of policymaking.

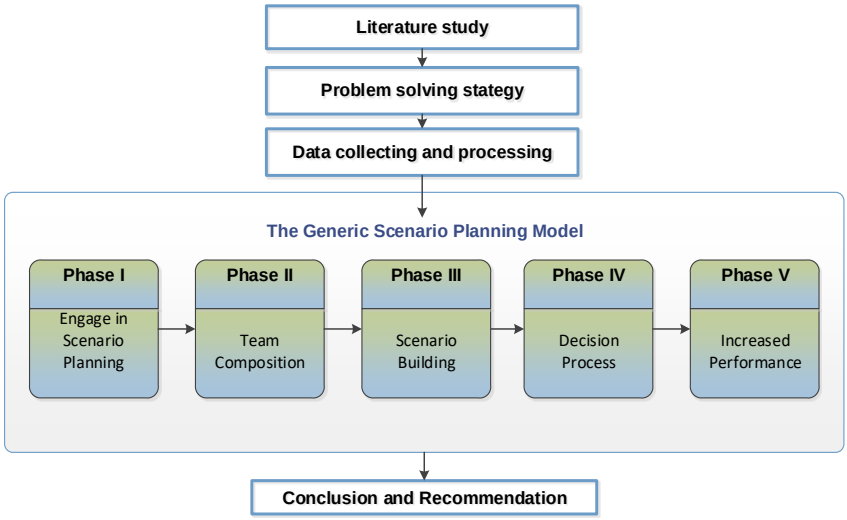

Fig.1. The research conceptual framework uses The Generic Scenario Planning Model. Source: [14]

2.2 Study site description

As explained, *Rimbawan* become a MoEF personnel who assists technical community empowerment in forest management unit (KPH), forest area with special purpose (KHDTK), and technical implementation units (UPT). They can actively engage in the productive forest advisory of people's plantation forests (HTR), community forests (HKm), village forests (HD), people's forests (HR), and people's seedling gardens (KBR), and the conservation of village models (MDK). Furthermore, *Rimbawan* supports forestry technical counseling together with the provincial and district/city, state-owned enterprises (BUMN), village-owned enterprises (BUMD), privately-owned enterprises (BUMS), and cooperatives. According to Regulation of the MoF, *Rimbawan* is a graduate of the Forestry Secondary School (SMK)/ Diploma/Bachelor/ Postgraduate from various disciplines, preferably those from forestry disciplines, especially forestry development.

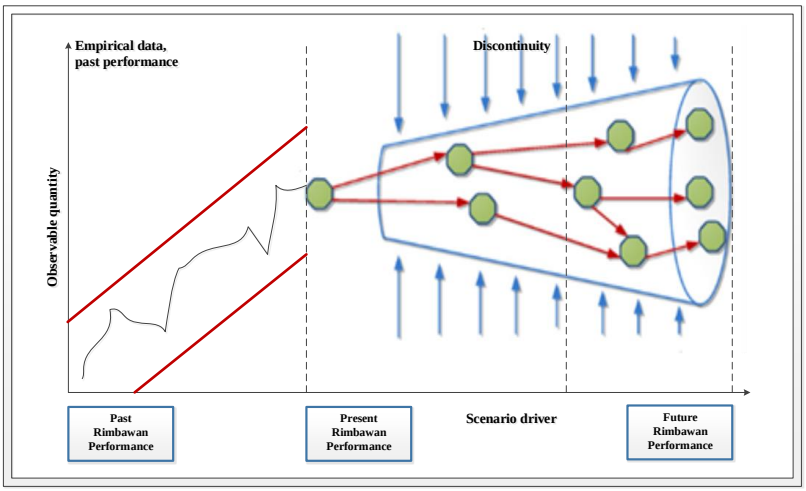

Fig. 2. Scenario Cone Showing Multiple Possibilities. Source: [15]

Recently, better-sense scenario planning surfaced because of diverging possibilities and empirical data values (Figure 2). More precisely, item analysis uses scenario dimensions to refine perceptions of emerging past performance problems. It specifies *Rimbawan's* present performance toward spotting future early warning signals in decreasing forest fire areas.

3 Results and discussions

3.1 Engaging in Scenario Planning

Organizational culture, time frame, and leadership issues are internal factors that must decide first in the engagement of a feasible scenario planning strategy.

Organizational culture. *Rimbawan's* performance is the best support in the utilization, cultivation, rehabilitation, and reclamation. They highly participate in the conservation of the natural forest. Belonging to that sustainable forest development culture, long-term forest fire management by *Rimbawan's* performance adopt a set of successful scenario planning strategies.

Time frame. The applicable time frame of *Rimbawan's* performance has three separable long-term perspectives. Firstly, it was developed for the purpose of forest fire precautions. Secondly, it was considered the basic function of forest firefighting. Thirdly, it was determined for focusing on post-forest fire handling. That reasonable time period for a return on systematic forest conservation is willing to get the most out of an investment in scenario planning.

Leadership. The support of top management to *Rimbawan's* performance plays a significant role in the proper execution of scenario planning. *Rimbawan's* performance is evaluated by BP2SDM-MoEF every year. Monitoring and evaluation are carried out in the form of an annual work plan, monthly reports, monthly attendance, and an online portal that can be seen at www.baktirimbawan.menlhk.go.id.

3.2 Team Composition

The success of the entire scenario process hinges on the team members. Properly composing a scenario planning team seems complex. So, creating a wide range of realistic indicators and verifiers was guidance on how *Rimbawan* is to be performed. These are the necessary measures to ensure an adequate level of diversity and balance in the team provided [16]. This capable team indicator and verifier were so credible that the organization will build appropriate *Rimbawan* performance scenario planning (Table 1).

Table 1. Indicator and verifier of appropriate *Rimbawan* performance

No.	Time frame	Indicator	Verifier
1	Forest fire precautions	*Rimbawan* conducts advisory on forest fire precautions.	Counseling on the prevention of forest fires at least between May - July, which is one month carried out 1-2 times activities in all conditions.
			The counseling material provided is how to prevent the occurrence of forest fires, how to make fire barriers, and how to extinguish forest fires efficiently.
			Counseling is given to people who live around and within forest areas.
		Rimbawan invites the community to participate in the control of forest fires.	*Rimbawan* formed MPA (*Masyarakat Peduli Api*) together with community, *Manggala* Agni, forest fire brigade, and company that owns the concession.
			Rimbawan together with related agencies routinely conduct institutional development of MPA. This is done at

No.	Time frame	Indicator	Verifier
			least between May and July 1-2 times in one month.
			Rimbawan together with related agencies involve MPA in patrolling forest prevention activities.
			Rimbawan provides mentoring materials to the MPA. Mentoring materials can be: knowledge of hotspots, how to create canal barriers, how to overcome hotspots and how to extinguish fires properly and correctly.
			Rimbawan coordinates and communicates intensively with the parties.
		Rimbawan coordinates to *Manggala* Agni.	Coordination to *Manggala* Agni is carried out at least between May and July as many as 2-3 times in one month.
			KPH and *Manggala* Agni always coordinate mainly for the implementation of integrated patrols and hotspot ground check activities during the summer.
		Rimbawan provides information on forest prevention using various media for the installation of warning boards or repair of forest warning boards in areas prone to forest fires.	*Rimbawan* ensures the installation of information boards in forest-prone areas.
			Rimbawan describes information intensively through WhatsApp groups.
			The information conveyed includes Information on the existence of hotspots and the number of hotspots.
		Rimbawan conducts forest prevention patrols.	Patrols are carried out at least between August and October 2-3 times in 1 month.
			The output form of patrol activities is a written report known to the section head and the head of the UPTD.
2	Forest firefighting	*Rimbawan* processing information about hotspots.	Processing of hotspot information data obtained from LAPAN is carried out at least between July and October.
			Hotspots located in concession areas that enter the KPH area are the responsibility of KPH and concession permit holders.
		Rimbawan checks hotspots in the field.	Checking hotspots in the field is carried out with other parties (Manggala Agni, Brigdalkarhutla TNI, POLRI, BPBD and MPA).
			Conducted at least between July and October, done every day with hotspot data information criteria has a confidence level of ≥ 60%.
		Rimbawan performs forest fire extinguishing	*Rimbawan* with related parties to carry out forest fires.
			Done at least between July and October, every time there is a forest in the field.
			The procedure for extinguishing forest fires is carried out in accordance with technical instructions depending on the type of fire.
3	Post-forest fire handling	*Rimbawan* mapping the area of former forest fires.	Conducted in coordination with the Provincial Forest Service.
			It is done at least once a year between November and January.
			Created based on the results of taking coordinate points and taking aerial photos using drones and processed with Argis Map.
			Made to know the extent of the forest fires that occurred in that year.
		Rimbawan conducts investigations and investigations to find the cause of forest fires in the former forest land.	Conducted with related parties (Law Enforcement Center (GAKKUM), Manggala Agni, and Police)
			It is done at least once a year between November and January.
		Rimbawan conducts efforts to rehabilitate the land area of former forest fires.	Conducted with related parties (Watershed Management Center (BPDAS) and Provincial Forest Service.
			Performed at least once a year between November and January.

3.3 Scenario Building

Begins with understanding or defining the issues at hand followed by a systematic Avin's 12-step scenario-building model identification (Figure 3).

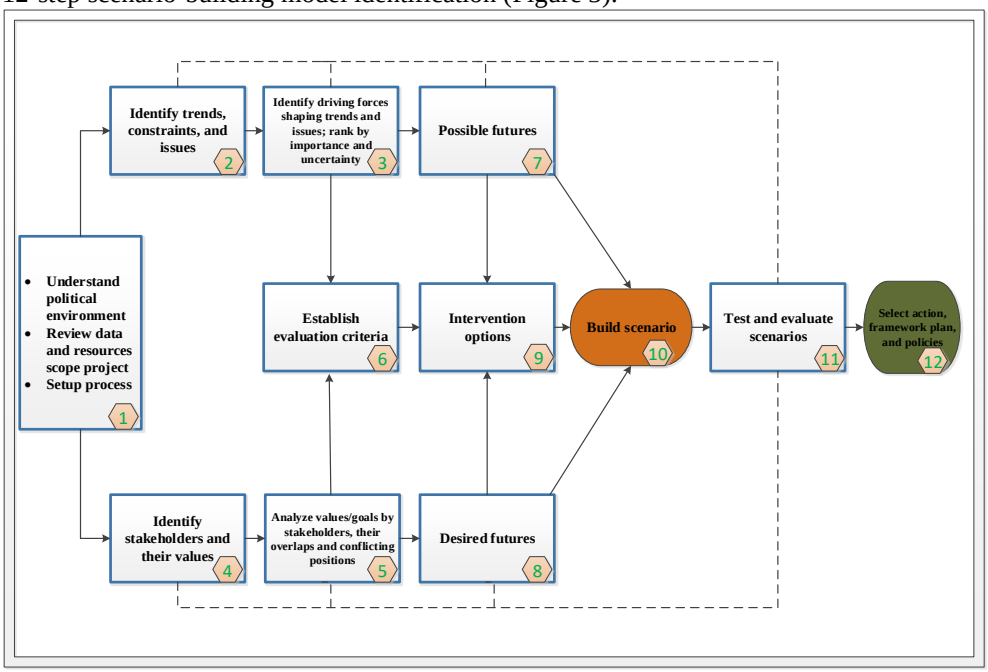

Fig. 3. Avin's 12-Step Scenario Building Model.
Source: [14]

Understand political environment, review data and resources scope project, and setup process. To date, evidence found that forest fires area in South Sumatra Province continuing over the last five years. The average forest fire area in South Sumatra Province based on their KPH from 2015-to 2019 is **30.71** percent (Table 2). Up to now, the research has tended to focus on problems or impacts of forest fires rather than on how much *Rimbawan's* performance is made in decreasing forest fires area. Until recently, there has been little interest in associating *Rimbawan's* contribution to their organization.

Identify trends, constraints, and issues. Begins with *Rimbawan's* performance investigation by a symmetric agree-disagree scale for a series of statements to specify their quality level: very high, high, moderate, low, or very low. So far, being understanding of contradictory findings in Figure 4, there are two results: linear results and non-linear results. Firstly, the linear defining is when the high quality of the performance follows by the low quality of the forest fires area. Such as in KPHP Region XII Benakat (Unit VII), KPHP Region XIII Lakitan – Bukit, KPHP Region II Lalan (Unit II), KPHP Region I Meranti, KPHP Region XIV Rawas, KPHP KPHL Region IX Suban Jeriji (Unit XIV), KPHL KPHP Region VII Mekakau - Saka (Unit XIX), KPHL Region III Palembang – Banyuasin, KPHL Region X Dempo (Unit XII) and KPHK Region VIII Semendo Unit XIII. Secondly, the non-linear definition is when the high quality of the performance follows by the high quality of the forest fires area. On the other hand, the low quality of the performance follows by the low quality of forest fires area. It's defining occurred in KPHP Region V Lempuing - Mesuji (Unit XXI), KPHP Region VI Bukit Nanti - Martapura (Unit XX), KPHP Region IV Sungai Lumpur - Riding and KPHK Padang Sugihan.

Table 2. The percentage of forest fire in South Sumatra Province based on their KPH from 2015-to 2019

No.	KPH in South Sumatra Province	Total areal KPH (hectares)	The amount of forest fire											
			2015		2016		2017		2018		2019		Average	
			ha	%	ha	%	ha	%	ha	%	ha	%		
1	KPHP Wilayah XII Benakat (Unit (VII)	256,511.11	62,931.00	24.53	1,310.00	0.51	120.00	0.05	732.00	0.29	10,518.00	4.10	75,611	29.48
2	KPHP Wilayah XIII Lakitan – Bukit Cogong (Unit VI)	76,776.00	7,587.00	9.88	16.00	0.02	0.00	0.00	0.00	0.00	4,506.00	5.87	12,109	15.77
3	KPHP Wilayah II Lalan (Unit II)	265,953.00	45,314.00	17.04	447.00	0.17	15.00	0.01	159.00	0.06	21,669.00	8.15	67,604	25.42
4	KPHP Wilayah V Lempuing – Mesuji (Unit XXI)	55,450.00	1,449.00	2.61	165.00	0.30	142.00	0.26	579.00	1.04	39,463.00	71.17	41,798	75.38
5	KPHP Wilayah VI Bukit Nanti – Martapura (Unit XX)	30,496.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	3,256.00	10.68	3,256	10.68
6	KPHP Wilayah I Meranti	315,000.00	266,169.00	84.5	0.00	0.00	0.00	0.00	0.00	0.00	20,438.00	6.49	286,607	90.99
7	KPHP Wilayah XIV Rawas	121,585.00	1,157.00	0.95	0.00	0.00	0.00	0.00	0.00	0.00	830.00	0.68	1,987	1.63
8	KPHP Wilayah IV Sungai Lumpur – Ridding	613,200.00	66,106.00	10.78	65.00	0.01	0.00	0.00	1,195.00	0.19	53,721.00	8.76	121,087	19.75
9	KPHP Wilayah IX Suban Jeriji (Unit XIV)	179,339.23	13,420.00	7.48	0.00	0.00	67.00	0.04	0.00	0.00	0.00	0.00	13,487	7.52
10	KPHL & KPHP Wilayah VII Mekakau – Saka (Unit XIX)	156,177.00	636.00	0.41	0.00	0.00	0.00	0.00	0.00	0.00	198.00	0.13	834	0.53
11	KPHL Wilayah III Palembang – Banyuasin	70,290.00	3,962.00	5.64	0.00	0.00	0.00	0.00	33.00	0.05	231.00	0.33	4,226	6.01
12	KPHL Wilayah X Dempo (Unit XII)	20,889.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
13	KPHK Wilayah VIII Semendo (Unit XIII)	15,491.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
14	KPHK Padang Sugihan	88,300.00	67,086.00	75.98	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	67,086	75.98
Total		**2,265,457.34**	**535,817.00**	**23.65**	**2,003.00**	**0.09**	**344.00**	**0.02**	**2,698.00**	**0.12**	**154,830.00**	**6.83**	**695,692**	**30.71**

Source: Website of Dinas Kehutanan, South-Sumatera Province and Direktorat Pengendalian Kebakaran Hutan dan Lahan, MoEF

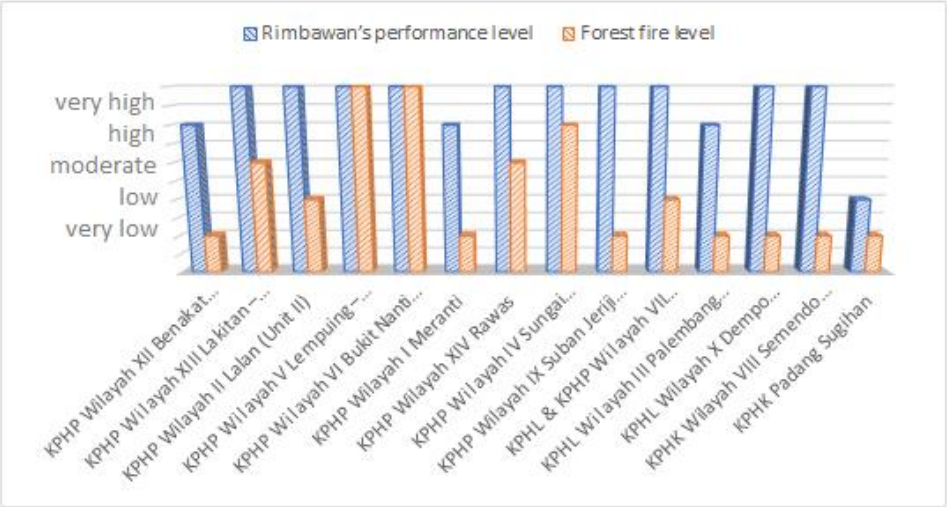

Fig. 4. Trends in *Rimbawan's* performance level may influence the decreased forest fire area in South Sumatra Province based on their KPH.

Identify driving forces shaping trends and issues, rank by importance and uncertainty. During the long-term perspectives of forest fire control, *Rimbawan's* performance has three separable time frames: forest fire precautions (X1), forest firefighting (X2), and post-forest fire handling (X3). In the present study, they represent a *Rimbawan's* performance level that may influence the decreased forest fire area. For further analysis, it can be formulated as follows hypothesis:

H_0 = The increase in *Rimbawan's* performance (forest fire precautions, forest firefighting, and post-forest fire handling) has nothing to do with the decrease in forest fires area in South Sumatra Province based on their KPH.

H_1 = The increase in *Rimbawan's* performance (forest fire precautions, forest firefighting, and post-forest fire handling) has decreased the forest fire area in South Sumatra Province based on their KPH.

Identify stakeholders and their values. The value of Nagelkerke R Square from the logistic regression test coefficient of determination obtained is 14%. It means that a level of forest fire precautions (C / X_1), forest firefighting (P / X_2), and post-forest fire handling (PC / X_3) can only explain 14%, while other factors explain the remaining 86%. The Hosmer and Lemeshow test value on the SPSS output result is 0.175. Since the value is $P > 0.05$, the null hypothesis is accepted. This means that the model can be used even if it only explains as much as 14% to predict the level of forest fires. But only C/X_1 is affecting the forest fire because $P < 0.05$ that the null hypothesis is rejected.

Table 3. Model's Summary

Step	-2 Log likelihood	Cox & Snell R Square
1	102.332[a]	.105

Note: [a] Estimation terminated at iteration number 5 because parameters estimates changed by less than .001.

Table 4. Analysis of Hosmer and Lemeshow.

Step	Chi-square	df	Sig.
1	8.976	6	.175

Table 5. Variables in the Formula

		B	SE	Wald	df	Sig.	Exp (B)
Step 1 [a]	Total prevention	.203	.096	4.534	1	.033	1.226
	Total extinction	.137	.273	.253	1	.615	1.147
	Total post	-.245	.311	.624	1	.430	.782
	Constant	-4.302	2.067	4.333	1	.037	.014

Note: [a] Variable (s) entered on step 1: total prevention, total extinction, total post

Table 3,4 and 5 is describe the value of Nagelkerke R Square from the logistic regression test coefficient of determination**.**

Analyze values/goals by stakeholders, their overlaps, and conflicting positions. So, the equation model from the results of the logistic regression analysis is:

$$ln\left(\frac{P(xi)}{1-P(xi)}\right) = -4.302+0.203x1 \quad (1)$$

$$\left(\frac{P(xi)}{1-P(xi)}\right) = exp\,(-4.302+0.203x1) \quad (2)$$

$$P(xi)) = \frac{exp\,(-4.302+0.203x1)}{1+exp\,(-4.302+0.203x1)} \quad (3)$$

Odd ratio interpretation:
$x_1 = exp\,(0.203)$
$x_1 = e^{0.203}$
$x_1 = 1.226$

To put in the numbers, the result shows that an increase in forest fire precautions by 1 level will cause the probability of forest fires to decrease by 1,226 times.

Establish evaluation criteria. As summarized in the previous validation result, it is the first criterion to review the attempt of forest fire precautions. *Rimbawan* needs to enhance the awareness of forest communities and their well-being in decreasing forest fire areas[17].

Possible futures. The trends of the future *Rimbawan* performance can affect monitoring forest fire areas and defining the roadmaps and priorities for future forest sustainability[18]. Identify a lack of skills in forest fire precautions gap.

Desired futures. Develop the training and implementation of new technologies in the education for future *Rimbawan* performance. Hard and soft competency, safety-enhancing, and well-being in operations of forest fire precautions are the necessity of the new skill[19].

Intervention options. Scenario planning is sufficient information for dealing with uncertainty. Intervention options are required when different events occur, such as a natural probability. The causes of increased forest fires area are intervening under a human and non-human heading[20].

Build scenario. Scenarios that will be beneficial for *Rimbawan* performance are likely to be most developed with the intent of identifying or solving specific problems. Support and train *Rimbawan* to be able to map competencies and detect the existing policy gaps in their operations.

Test and evaluate scenarios. There is a shortage of skilled *Rimbawan* performance across forest fire precautions. Current education and training programs sufficiently consider a relevant topic by education and training institutions. To evaluate available programs and promote the reconversion test, including new competencies and skills demanded.

Select action, framework plan, and policies. It comprises a series of action plans to address through a concise and well-established framework plan. Provide a meaningful and summarized description of the selected recommendations in interlinked climate codification,

several hotspots, wood vegetation, peat vegetation, water supply availability, population activities, livelihoods, and road networks.

3.4 Decision Process

This research has compared the performance of *Rimbawan* and the controllable forest fire area and found that 1 level of an increase in forest fire precautions activities will reduce the probability of forest fires by 1,226 times. What is striking in this research is that the model only explains 14%, while in that trial, other factors explained the remaining (86%). Therefore, the interpreted decision process needs caution. The model outline presented in Figure 5 is how specifically scenario planning can improve decision-making. Should be these decision processes benefit from reduced bounded rationality, the consideration of exogenous and endogenous variables, reduced information stickiness, increased knowledge friction, and alternative mental models [14]. Sonor rice cultivation, land clearing by burning for agricultural purposes, and fish-seeking activities are rational triggers for fires in South Sumatra Province. The exogenous activities of companies holding land concessions consider being one of the variables of the increased forest fires. The information on hotspots amount in production forest areas (HP) is related to factors from the management of industrial plantation forest areas (HTI). Building canals without regard to land contours causes physical changes in peat to dry. All conditions ultimately cause flammable forests and are aggravated by the soil type in South Sumatra Province.

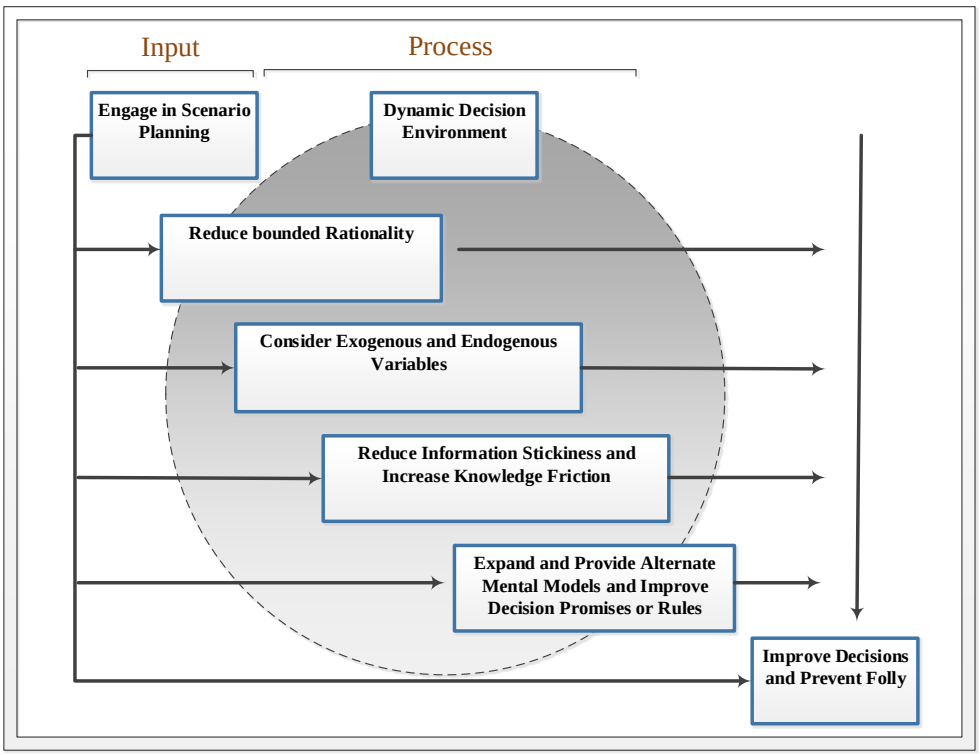

Fig. 5. Conceptual Model of Improved Decision Making Through Scenario Planning
Source: [14]

3.5 Increased Performance

It is interesting to note that there has been a fluctuation in the number of forest fires from 2015 to 2019. Around 695,692 hectares of those 2,265,457.34 hectares of KPH (*Kesatuan Pengelolaan Hutan*) area in South Sumatra Province occurred that forest fires area. What can be seen in these forest fires during five years is 26.68 percent. However, this study set out with upscaling *Rimbawan* performance in forest fire precautions across the increasing forest fires area. Figure 5 reveals that *Rimbawan's* performance on a theoretical model of scenario planning can be upscaled as follow: the level of conversation quality and engagement in the productive forest advisory; education learning to support forestry technical counseling; the better quality of the decision-making style by job training participation; development of *Rimbawan* mental models; and the greater level of leadership support to accelerate *Rimbawan* job motivation.

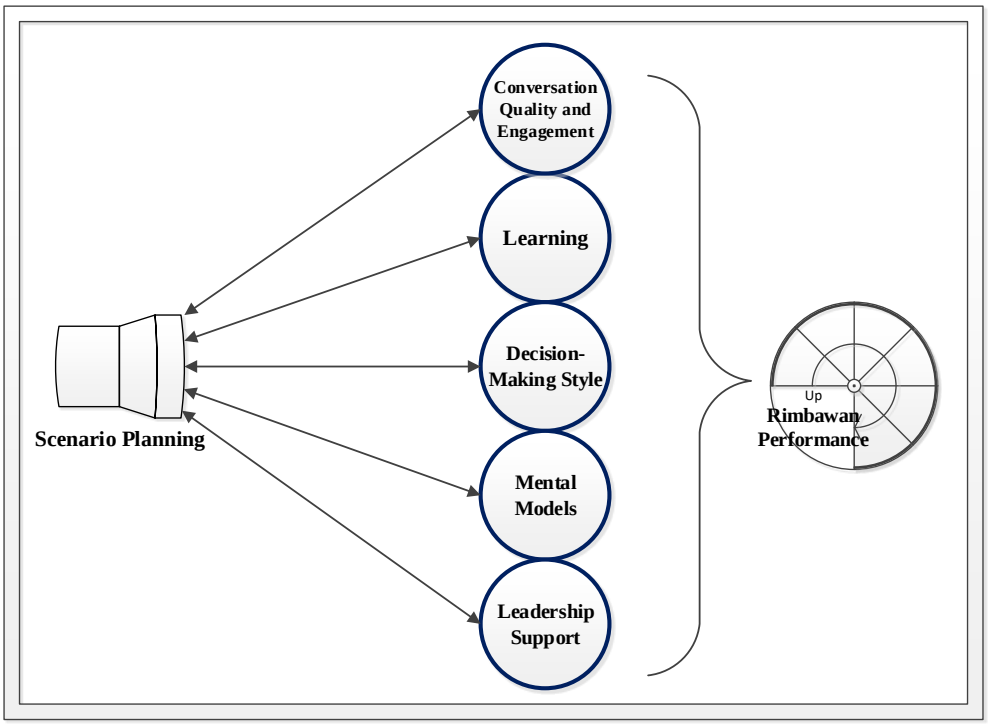

Fig. 6. The Framework of the Upscaling *Rimbawan* Performance on a Theoretical Model of Scenario Planning
Source: [14]

4 Conclusions and recommendations

4.1 Conclusions

It is the first study of a substantial study site in the KPH (*Kesatuan Pengelolaan Hutan*) area in South Sumatra Province that examines the association between *Rimbawan's* performance level and decreasing the forest fires area. The current data highlight **30.71** percent of forest fires during five years from those 2,265,457.34 hectares of KPH. The main goal of the research was to relevance *Rimbawan's* performance contribution toward decreasing the forest fires area. Taken together, the findings of *Rimbawan's* performance level elaborate that 1

level of an increase in forest fire prevention activities will reduce the probability of forest fires by 1,226 times. An appropriate scenario planning theoretical model has a significant result for understanding how upscaled *Rimbawan's* performance level is through conversation quality and engagement, learning, decision-making style, mental models, and leadership support.

4.2 Recommendation

This study presented the association between *Rimbawan's* performance level contributing to the probability of forest fires. However, further development, refinement, and case study testing of concepts and methods are needed. An issue not addressed in this study was other variables that affect forest fires, such as humans (community conditions in site around the forest), damage to peat ecosystems, and weather factors.

References

1. N. A. Wi, Analisis Kinerja Polisi Kehutanan Dalam Perlindungan Hutan DI Kabupaten Sinjai, Universitas Hasanuddin, 2017.
2. M. S. Imanudin, M. E. Armanto, and P. Dwi, in *Semin. Nas. Etika Lingkung. Dalam Eksplor. Sumberd. Pangan Dan Energi, BKPSL Indones.* (2015), pp. 1–12.
3. P. Meissner and T. Wulf, Technol. Forecast. Soc. Change **80**, 801 (2013).
4. M. Stute, S. Sardesai, M. Parlings, P. P. Senna, R. Fornasiero, and S. Balech, *Technology Scouting to Accelerate Innovation in Supply Chain* (2021).
5. R. Vecchiato, Long Range Plann. **52**, (2019).
6. E. L. Bohensky, B. Reyers, and A. S. Van Jaarsveld, Conserv. Biol. **20**, 1051 (2006).
7. A. Volkery and T. Ribeiro, Technol. Forecast. Soc. Change **76**, 1198 (2009).
8. E. Oteros-Rozas, B. Martín-López, T. M. Daw, E. L. Bohensky, J. R. A. Butler, R. Hill, J. Martin-Ortega, A. Quinlan, F. Ravera, I. Ruiz-Mallén, M. Thyresson, J. Mistry, I. Palomo, G. D. Peterson, T. Plieninger, K. A. Waylen, D. M. Beach, I. C. Bohnet, M. Hamann, J. Hanspach, K. Hubacek, S. Lavorel, and S. P. Vilardy, *Participatory Scenario Planning in Place-Based Social-Ecological Research: Insights and Experiences from 23 Case Studies* (2015).
9. J. J. Oliver and E. Parrett, Bus. Horiz. **61**, 339 (2018).
10. K. von Gadow and J. Puumalainen, 319 (2000).
11. L. Rickards, J. Wiseman, T. Edwards, and C. Biggs, Environ. Plan. C Gov. Policy **32**, 641 (2014).
12. I. G. A. A. K. Sentanu, I. G. A. Komang, D. Djuni, N. Pramaita, M. Program, S. Elektro, F. Teknik, and U. Udayana, J. Spektrum **8**, 286 (2021).
13. K. Budiningsih, J. Anal. Kebijak. Kehutan. **14**, 165 (2017).
14. S. M. Keough and K. J. Shanahan, Adv. Dev. Hum. Resour. **10**, 166 (2008).
15. M. Amer, T. U. Daim, and A. Jetter, Futures **46**, 23 (2013).
16. G. Jalilova, C. Khadka, and H. Vacik, For. Policy Econ. **21**, 32 (2012).
17. D. J. Shinneman, B. J. Palik, and M. W. Cornett, For. Ecol. Manage. **274**, 126 (2012).
18. R. Scheller, A. Kretchun, T. J. Hawbaker, and P. D. Henne, Ecol. Modell. **401**, 85 (2019).
19. E. S. Abelson, K. M. Reynolds, P. Manley, and S. Paplanus, For. Ecol. Manage. **497**, 119533 (2021).
20. B. A. Bagdon, C. H. Huang, and S. Dewhurst, Ecol. Modell. **324**, 11 (2016).