LEMBAR
HASIL PENILAIAN SEJAWAT SEBIDANG ATAU *PEER REVIEW*
KARYA ILMIAH : *PROSIDING*

Judul karya ilmiah (paper) : Adaptation Strategies of Grobogan Regency Farmers in Face of Climate Change

Jumlah Penulis : 4 orang

Status Pengusul : **Landung Esariti,** Rizqita Shofa Nida, Wiwandari Handayani dan Iwan Rudiarto

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a. Kelengkapan artikel cukup, metode IMRAD dipakai. Tidak ada *acknowledgement* di akhir artikel.

b. Pembahasan artikel cukup mendalam, menggunakan referensi sebanyak 20 artikel dari 23 artikel adalah jurnal internasional terbitan 10 tahun terkini Artikel membahas hubungan antara penurunan produktivitas

pertanian dengan perubahan iklim, dan merekomendasikan beberapa strategi terkait pengembangan wilayah di Kab. Grobogan

c. Prosiding terindeks Scopus (IOP Series) tersedia online dan open access. Prosiding dilengkapi dengan ISBN, DOI, dan terkategori internasional.

d. Analisis menggunakan metode kuantitatif dan disajikan dengan data hasil survei primer dan dilengkapi peta tipologi penggunaan lahan pertanian.

Semarang, 17 Mei 2023

Reviewer 1,

Dr. Ir. Hadi Wahyono, MA
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Total = (100%)	**22,5**		**22,5**
Nilai Pengusul : 0,6 x 22,5			**13,5**

Catatan Penilaian paper oleh Reviewer :

a. Artikel telah memenuhi kaidah penulisan akademik, pada prosiding internasional terindeks Scopus. Dipresentasikan dalam konferensi dengan peserta yang bervariasi asal negaranya.

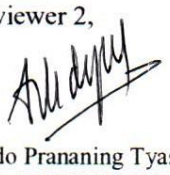
b. Pembahasan telah fokus dan mendalam terkait pada tipologi aktivitas pertanian yang terpengaruh dari perubahan iklim di Kab. Grobogan. Peta dan analisis yang detail disajikan dengan dukungan penjelasan dari ekplorasi data primer dan sekunder.

c. Tema cukup terbaharukan, tentang adaptasi masyarakat pada kondisi perubahan iklim. Hal ini sesuai dengan bidang kajian di bidang pengembangan wilayah dan kota. Pembahasan pada artikel juga telah sesuai dengan peta jalan penelitian Tim Penulis.

d. Prosiding terindeks Scopus dengan publikasi cetak dan online yang dapat diakses dengan mudah. Publikasi artikel telah memenuhi review dengan scientific committee yang terdiri dari 4 negara peserta.

Semarang, 17 Mei 2023

Reviewer 2,



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[ ] *Prosiding* Forum Ilmiah Nasional

Hasil Penilaian *Peer Review* :

Komponen Yang Dinilai	Nilai Reviewer		Nilai Rata-rata
	Reviewer I	Reviewer II	
a.Kelengkapan unsur isi paper (10%)	2	1,5	1,75
b.Ruang lingkup dan kedalaman pembahasan (30%)	7,5	7	7,75
c.Kecukupan dan kemutahiran data/informasi dan metodologi (30%)	7	7	7
d.Kelengkapan unsur dan kualitas terbitan/prosiding (30%)	7	7	7
Total = (100%)	**23,5**	**22,5**	**23**
Nilai = 60% x 23			**13,8**

Semarang, 17 Mei 2023

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Reviewer 2,

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Preface

Environment, Health and Safety

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Adaptation Strategies of Grobogan Regency Farmers in Face of Climate Change

L Esariti[1], R S Nida[1], W Handayani[1] and I Rudiarto[1]

IOP Conference Series: Earth and Environmental Science, Volume 1098, The 4th International Conference on Environment, Sustainability Issues, and Community Development (INCRID) 01/09/2022 - 01/09/2022 Semarang, Indonesia

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Abstract

The advent of climate change in Grobogan Regency is marked by the lengthy dry season, prevalence of rat attacks and changes in the growing season due to weather instability. This article aims to explore adaptation strategies for farmers in dealing with the problem of declining crop productivity due to climate change. Based on observations, expert interviews, and questionnaires delivered to the population, it was concluded that the strategies implemented among the farmers were aimed at maintaining livelihoods. The survey results indicated that there were different agricultural patterns in the western and eastern parts of Grobogan Regency and, as such, the farmers employed different adaptation strategies respective to their locations. In West Grobogan, focus was put on managing farmland with irrigation sourced from the Glapan dam. Meanwhile, in East Grobogan, rainfed agriculture, particularly for corn and soybean commodities, was customary. Analysis of the exploratory research suggested that 2 adaptation strategies are implemented by the farmers. First, the farmers commonly migrate and seek supplementary jobs to ensure income stability. Second, the farmers use planting techniques and seeds with superior quality and short harvest periods, which they invented.

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New risk assessment and prioritization failure modes based approach in a gas turbine system

New risk assessment and prioritization failure modes based approach in a gas turbine system

A Chakhrit[1]*, M Bougofa[2], I H M Guetarni[1], N Nehal[1], A Bouafia[3], F Z Ghazli[1], R Kharzi[2], and M Chennoufi[1]

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Abstract. The dependability occupies a strong place in the performance achievement of the system. It describes the mechanisms that lead to failures of systems. Failure mode and effects, analysis (FMEA) is a classical safety technique widely used in several safety critical industries. This method uses the risk priority number (RPN) to assess the criticality value and prioritize failure modes. However, it suffers from some drawbacks regarding the situation where the in-formation provided is ambiguous or uncertain. Thus, in this work, a fuzzy criticality assessment based approach is carried out to evaluate the failure modes of the relevant system and gives an alternate prioritizing to that obtained by the conventional method. In addition, a novel hybrid approach is proposed that combines the grey relational approach (GRA) and fuzzy analytic hierarchy process. This approach offers a new ranking of failure modes by solving the shortcoming concerning the lack of established rules of inference system which necessitate a lot of experience and shows the weightage or importance to the three parameters severity, detection, and frequency, which are considered to have equal importance in the traditional method. A real case study from a gas turbine system provides encouraging results regarding the risk evaluation and prioritizing failures mode with handling different forms of ambiguity, uncertainty, and divergent judgments of experts.

1. Introduction

Failure mode and effect analysis (FMEA) is vastly employed as an analytical methodology for recognizing , ranking, and reducing different failures modes[1]. For such failure mode, three criticality factors: severity (S), non-detection (ND), and frequency (F) are assessed, and a risk priority number (RPN) is computed by multiplying these factors to evaluate the risk value[2] [3, 4].

Moreover, it demonstrates in different of applications that the FMEA still has many flaws. First, different integration of severity, detection, and frequency factors can provide an equal RPN value. While, the risk assessment for the different criticality can be wildly different. Second, in the

calculation of the risk priority number, the potential importance of criticality parameters is not considered. Other disadvantage of the traditional FMEA methodology is the specific assessment of criticality factors concerning each failure mode. Nevertheless, because of restricted data and time pressure, criticality factors cannot correctly evaluating and the risk assessment process can be imprecise or uncertain [5-7].

To solve the flaws, several ameliorated FMEA method was suggested by different works. Ilangkumaran et al [8] suggested a risk assessment model based on analytic hierarchy method to assess the risk level of important failures in the paper industry. For the criticality assessment of risk in a 2- dimensional ambiguous linguistic context, Liu et al [9] utilized the interval 2-tuple hybrid weighted distance (ITHWD) measure; then Liu et al [10] employed the alternative queuing approach in order to classify the criticality of the different failure modes. Certa et al [11] gave an ELECTRE TRI-based approach to find risk level group of failure modes based on criticality factors. However, they still show some shortcomings due to the complication and ambiguity of the conventional technique. For this case, many researchers have utilized fuzzy system to resolve the issues mentioned above [12]. Wang et al [13] utilized the criticality parameters as fuzzy values for risk assessment and ranking of failure modes in FMEA. Liu et al [14] arranged and ranked the risk evaluation approach in FMEA to represent the links between risk parameters and riskiness[15,16]. More recently, a novel integrated decision-making model that combined the fuzzy analytic hierarchy process and grey relation analysis method were suggested by Chakhrit and Chennoufi[17]. They provided an alternative ranking for failure modes which reduce the shortcoming of insufficient constructed inference rules, which require a lot of experience.

In light of the research problem previously mentioned, the originality and innovations of this research is based to reduce the ambiguity and minimize the judgments uncertainty, for that a novel hybridized approach that integrates the GRA method and fuzzy AHP method may resolve this issue. This model provides an alternative ranking for the criticality and enables reducing the flaws regarding the deficiency of constructed inference rules that requires a lot of experience, and give the weightage for the different factors, which are estimated to be equally important in the conventional FMEA technique.

2. Fuzzy risk evaluation model

As being the FMEA method has considerable shortcomings in the calculation process and risk interpretation for these reasons a fuzzy risk evaluation based approach is given in section 2. The notion of fuzzy sets that was developed by Zadeh is the foundation for the fuzzy risk assessment model. It gives a more reliable to assess risk related with various failure modes [21], where the different factors utilized in the conventional technique will be fuzzified by using a proper membership function that employs knowledge rules IF - THEN that come from expert opinion, where the relation is represented as:

$$\text{criticality} = \text{frequency} \times \text{severity} \times \text{detection} \quad (1)$$

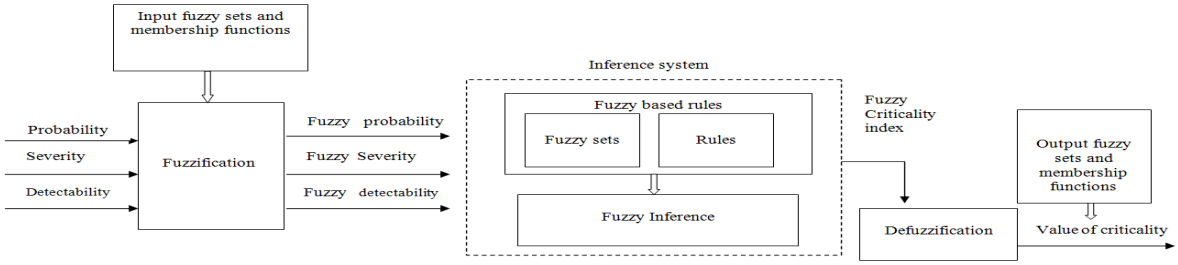

Figure 1. Fuzzy risk model

3. Proposed approach

A new model that integrates the GRA approach and fuzzy AHP is proposed to resolve flaws of the traditional technique. The proposed model can be acquired by the subsequent phases (figure 2).

3.1. Recognizing comparative series

The comparative series is a data set that contains values for the relevant components. The comparison series, which includes the three factors mentioned above, is as follows:

$$r_i(m) = (r_i(1), r_i(2), r_i(3), \ldots . r_i(m)) \in R, \ldots i = 1,2,3, \ldots n \quad (2)$$

Where m denotes the risk parameters number and n is the failure modes number. r_i(m) represents the m[th] parameters of r_i and the n comparative series is given as follows:

$$r = \begin{bmatrix} r_1 \\ r_2 \\ . \\ . \\ r_n \end{bmatrix} \begin{bmatrix} r_1(1) & r_1(2) & \ldots & r_i(m) \\ r_2(1) & r_2(2) & \ldots & r_2(m) \\ . & & & \\ . & & & \\ r_n(1) & r_n(2) & \ldots & r_n(m) \end{bmatrix} \quad (3)$$

3.2. Standard series specification

Finding the degree of relation is the goal of recognizing the standard series; it displays the ideal level of all deciding elements. The standard series are as follows:

$$r_0(m) = (r_0(1), r_0(2), \ldots, r_0(m)) = (1,1, \ldots ., 1) \quad (4)$$

3.3. Comparative and standard Series differences

$$\Delta_{0i}(m) = \begin{bmatrix} \Delta_{01}(1) & \Delta_{01}(2) & \ldots & \Delta_{01}(m) \\ \Delta_{02}(1) & \Delta_{02}(2) & \ldots & \Delta_{02}(m) \\ . & & & \\ . & & & \\ \Delta_{0n}(1) & \Delta_{0n}(2) & \ldots & \Delta_{0n}(m) \end{bmatrix} \quad (5)$$

Where $r_0(m)$ is the standard series, $r_i(m)$ is the comparative series, and $\Delta_{0i}(m) = |r_0(m) - r_i(m)|$

3.4. the Grey Relationship Coefficient

The standard series is examined with three risk variables. The following formula is used to calculate the grey relationship coefficient for frequency, non-detection, and severity factors [22]:

$$\gamma(r_0(m), r_i(m)) = \frac{\Delta_{\min} + \zeta\Delta_{\max}}{\Delta_{0i}(m) + \zeta\Delta_{\max}} \quad (6)$$

ζIs a predetermined coefficient with a typical value of 0.5.

3.5. the Degree of relation determination

Equation 7 is used to estimate the relative value of each criticality factor if they are all of equal importance.

$$\tau_i(m) = \frac{1}{n}\sum_{m=1}^{n} \Delta_i(m) \quad (7)$$

If the risk factors have various importances:

$$\tau_i(m) = \sum_{m=1}^{n} \Delta_i(m)\, \beta(m) .. and \sum_{m=1}^{n} \beta(m) = 1 \quad (8)$$

3.5.1. Fuzzy analytic hierarchy method

Saaty developed the fuzzy analytic hierarchy. It is an excellent method for resolving decision-making issues. The Fuzzy AHP technique is shown below[23,24]:

Step 1: As shown in equation 9[25], a pair-wise comparison matrix is created. The expert is asked to express linguistic terms in pair-wise comparisons across all criteria using triangular fuzzy numbers utilizing expert questionnaires.

$$A= \begin{bmatrix} (111) & j_{12}h_{12}k_{12} & j_{1n}h_{1n}k_{1n} \\ j_{21}h_{21}k_{21} & (111) & j_{2n}h_{2n}k_{2n} \\ j_{n1}h_{n1}k_{n1} & j_{n2}h_{n2}k_{n2} & (111) \end{bmatrix} \quad (9)$$

A_{ij} is a fuzzy number (j, h, and k) for reciprocal $A^{-1} = (j,h,k)^{-1} = (\frac{1}{k},\frac{1}{h},\frac{1}{j})$

Step 2: Compute the fuzzy geometric mean for each criterion as indicated in equation. 10.

$$r_i: A1 \otimes A2 \otimes An = (j1, ℏ1, k1) \otimes (j2, ℏ2, k2)(jn, ℏn, kn) = (j1 * j2 *\ldots jn, ℏ1 * ℏ2 *\ldots ℏn, k1 * k2 *\ldots kn)^{1/n} \quad (10)$$

Step 3: The fuzzy weights are calculated using normalization. To determine the fuzzy weight of the ith criterion, apply the following equation:

$$w_i = r_i \otimes (r1 \oplus r2 \oplus \ldots \oplus rn)^{-1} \quad (11)$$

3.6. Criticality Ranking

The failure modes are prioritized according to how closely they are related to each other. Priority is given to the failure modes with the lowest degree of grey relation.

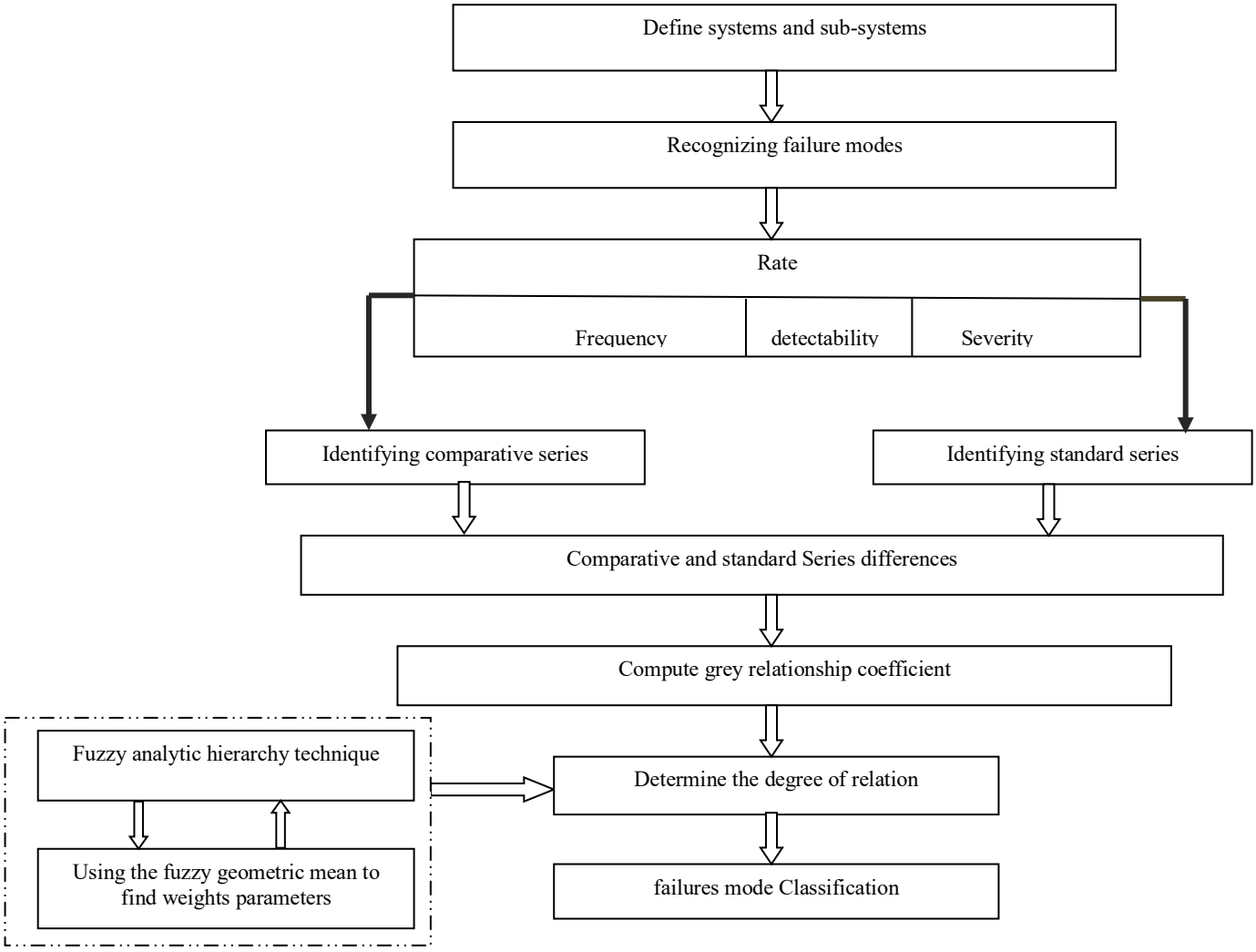

Figure 2. Grey proposed model

4. Case study

The system selected for this study is a gas turbine system, In Algeria, the spread of these systems are clearly seen. It is a combustion engine that can transform natural gas into mechanical energy. After that, a generator powered by this energy produces electricity. This system is shown in figure 3:

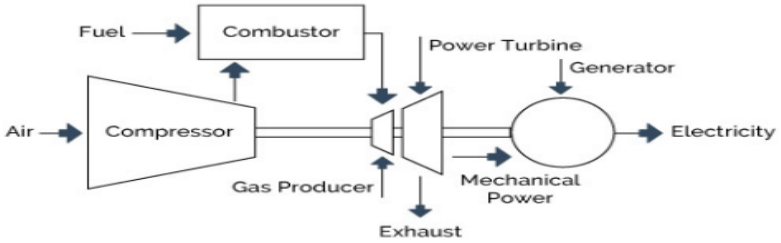

Figure 3. Gas turbine design

4.1. Proposed approach

FMEA data of the table 1 is employed in this part, and the grey relation method is used with different situations (risk factors with various and similar weights). The FAHP method is called to determine the risk parameters weights based on expert opinion.

The first step is to construct comparative series regarding to the various parameters by the matrix as follows.

$$\begin{bmatrix} r_1(1) & r_1(2) & r_1(3) \\ r_2(1) & r_2(2) & r_2(3) \\ & & \\ r_8(1) & r_8(2) & r_8(3) \\ & & \\ r_{14}(1) & r_{14}(2) & r_{14}(3) \\ r_{15}(1) & r_{15}(2) & r_{15}(3) \end{bmatrix} = \begin{bmatrix} 2 & 10 & 6 \\ 2 & 5 & 3 \\ & & \\ 5 & 6 & 6 \\ & & \\ 8 & 9 & 7 \\ 7 & 9 & 6 \end{bmatrix} \quad (12)$$

The difference between the standard and comparative series is given by Equation 5, which is shown in the matrix below.

$$\begin{bmatrix} \gamma_{01}(1) & \gamma_{01}(2) & \gamma_{01}(3) \\ \gamma_{02}(1) & \gamma_{02}(2) & \gamma_{02}(3) \\ . & . & . \\ . & . & . \\ \gamma_{08}(1) & \gamma_{08}(2) & \gamma_{08}(3) \\ . & . & . \\ \gamma_{014}(1) & \gamma_{014}(2) & \gamma_{014}(3) \\ \gamma_{015}(1) & \gamma_{015}(2) & \gamma_{015}(3) \end{bmatrix} = \begin{bmatrix} 1 & 0.4 & 0.58 \\ 1 & 0.64 & 0.85 \\ . & . & . \\ . & . & . \\ 0.64 & 0.58 & 0.58 \\ . & . & . \\ 0.48 & 0.44 & 0.52 \\ 0.52 & 0.44 & 0.58 \end{bmatrix} \quad (13)$$

As described previously, the grey relation coefficient is derived by equation 6.

$$\begin{bmatrix} \gamma_{01}(1) & \gamma_{01}(2) & \gamma_{01}(3) \\ \gamma_{02}(1) & \gamma_{02}(2) & \gamma_{02}(3) \\ . & . & . \\ . & . & . \\ \gamma_{08}(1) & \gamma_{08}(2) & \gamma_{08}(3) \\ . & . & . \\ \gamma_{014}(1) & \gamma_{014}(2) & \gamma_{014}(3) \\ \gamma_{015}(1) & \gamma_{015}(2) & \gamma_{015}(3) \end{bmatrix} = \begin{bmatrix} 1 & 0.4 & 0.58 \\ 1 & 0.64 & 0.85 \\ . & . & . \\ . & . & . \\ 0.64 & 0.58 & 0.58 \\ . & . & . \\ 0.48 & 0.44 & 0.52 \\ 0.52 & 0.44 & 0.58 \end{bmatrix} \quad (14)$$

If all risk factors have similar weights, equation 7 is used to compute the relation degree. For instance; the first failure mode is deduced as;

$$\tau_i(k) = \frac{1}{3}(\gamma_{01}(1) + \gamma_{01}(2) + \gamma_{01}(3)) = \frac{1}{3}(1 + 0.4 + 0.58) = 0.66$$

The second situation where the parameters with various weights; the fuzzy AHP technique is used to assign weights to the risk factors. The significance of the risk parameters has been compared by experts to triangular fuzzy values. The overall results are presented in table 2.

Table 1. Fuzzy weights calculation

	Frequency	**Non-detection**	**Severity**	Fuzzy geometric mean value r_i	Fuzzy weights w_i
Frequency	(1,1,1)	$(\frac{1}{7}, \frac{1}{6}, \frac{1}{5})$	$(\frac{1}{9}, \frac{1}{9}, \frac{1}{8})$	(0.251 0.264 0.292)	0.05
Non-detection	(5,6,7)	(1,1,1)	$(\frac{1}{9}, \frac{1}{8}, \frac{1}{7})$	(0.822 0.908 1)	0.173
Severity	(8,9,9)	(7,8,9)	(1,1,1)	(3.825 4.16 4.32)	0.777

Table 2. Ranking of conventional, fuzzy and GRA suggested model

Failure mode Sequence N°	Failure Mode	Cause	F	S	D	Conventional RPN	Ranking	Fuzzy RPN	ranking	GRA with similar weighs	ranking	GRA with different weight	ranking
1	Vibration	Incorrect signal	2	10	6	120	7	0.457	7	0.660	8	0.461	2
2		bearings not working	2	5	3	30	13	0.20	15	0.831	14	0.622	11
3	Over-temperature	soiled compressor rotor	3	5	4	60	10	0.250	13	0.737	11	0.666	14
4	Stall	changeable stator vanes Binding	3	6	4	72	9	0.274	12	0.718	10	0.619	10
5		Foreign objects degrade	3	4	5	60	10	0.230	14	0.737	11	0.600	9
6	Flame-out	Energy nozzles blockage	4	6	2	48	12	0.358	10	0.771	13	0.660	13
7	Hot spots on flame tube	Uneven flame dispersion around a malfunctioning flame tube.	4	7	2	56	11	0.370	9	0.751	12	0.649	12
8	Vibration	Defective vibration indication	5	6	6	180	5	0.457	6	0.567	3	0.583	8
9		Defective bearings	5	8	3	120	7	0.447	8	0.653	7	0.544	7
10	Over-speed	Excessive fuel flow	6	7	5	210	4	0.5	5	0.580	4	0.544	7
11	No start	particles, water, or air in fuel lines	2	9	5	90	8	0.308	11	0.693	9	0.500	4
12	Stall	irregular fuel pressure	6	8	5	240	3	0.531	4	0.600	5	0.512	5

13	Wrong temperature indication	short circuit in thermocouple circuit	6	9	3	162	6	0.572	3	0.620	6	0.516	6
14	Not reaching idle speed	Low electrical power	8	9	7	504	1	0.758	1	0.480	1	0.456	1
15	Defective speed indication	Internal tachometer failure	7	9	6	378	2	0.667	2	0.513	2	0.468	3

5. Results and discussion

Table 1 represents the findings of the different approach for gas turbine system. As given in the Table that the prioritization of failures mode obtained from the traditional FMEA is classified as FM14, FM15 FM12, FM10, FM8, FM13, (FM9, FM1), FM11, FM4, (FM5, FM3), FM7, FM6, FM2, respectively. However, after utilizing the fuzzy model provided a novel ranking for the criticality. For example, in the traditional methodology, FM13 was classified in the sixth rank. While, it ranked at the third classification in the fuzzy proposed model. Simultaneously, in both the methods, FM14 was the most critical mode.

By comparing the traditional finding of the fuzzy model with FMEA method, the flaws combined with conventional FMEA can evidently shown; the most significant flaw of the conventional methodology is that the various combinations of the different factors give an equal RPN value; however, the risk interpretations can be different, For instance, FM3and FM5 have an equal risk priority number of 60, while the risk outcome cannot exactly be the same, but the proposed fuzzy model differs in those. The second shortcoming of the traditional methodology disregards the importance between the different parameters. The three inputs are suggested to be equally important, but in actual implementations, the inputs' relative relevance is still present; for instance, the failure mode 13 with a moderate frequency, low detection, and very high severity (6, 3, 9) with a lower risk priority number of 162 than one with all factors moderate as the failure mode 8 with risk priority number of 180; on the contrary with the fuzzy model can distinctly observed that FM13 has a higher value than FM8with values 0.572, 0.457, and hence will be given more attention for preventive and corrective actions..

Concerning the suggested grey analysis model, there has been an observed variation in the ranking order with the previous approach. For example FM14, FM15 have higher priority in all model (the most significant modes of failure). Meanwhile, the failure mode 13 has lower priority in the suggested model and a higher classification in other models. The important cause is explicated by different risk assessment models and prioritization processes utilized in each approach.

Table 1 also represented the weightage of the different factors through the grey suggested model. When different weights parameters are utilized, it is clearly shown that is a marked rearranging in the classification for the failure modes, showing their importance. In the case of requests coming from modifications or variations, changing the weights can be a simple way to adjust the strategy. The GRA methodology is called when there are no particular inference rules that require a great deal of experience.

6. Conclusions

For identifying and rating potential failure modes in products and processes, FMEA has been broadly acknowledged as a standard technology technique. The traditional FMEA methodology received different criticism for its shortcomings, especially in the evaluation process and risk priority computation. In this work, a novel risk prioritization approaches to assess the criticality of the different failures in FMEA is proposed.

Compared to the traditional methodology, the advantage of fuzzy model evaluation permits experts to more objectives combining of the different factors by utilizing their experience to reduce the flaws creating in performing of the classical FMEA technique. This study represented the efficiency of the

fuzzy criticality approach to control various kind of ambiguities in the failure evaluation technique, such as, fuzziness, incompleteness and vagueness

Fuzzy analytic hierarchy and grey relation analysis approach are utilized in this study to assess and prioritize the failure modes more factual and dynamic. The results can give important outcomes in the decision-making process. The results represent in a real case study of risk ranking of failures modes that the combination of the fuzzy analytic hierarchy and grey relation analysis methods can give a more acceptable risk prioritization order. In addition, the proposed models can be used when the predetermined inference rules are inadequate and require a lot of expertise.

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The effectiveness of EM4 and Local Micro-organisms (LOM) Activators in Organic Waste Processing in Brikama Market West Coast Region, The Gambia

The effectiveness of EM4 and Local Micro-organisms (LOM) Activators in Organic Waste Processing in Brikama Market West Coast Region, The Gambia

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Abstract. Compost is the result of decaying process of organic materials due to the interaction between decomposing microorganisms found within. Compost is a type of organic fertilizer that originates from decomposed organic materials. Observations at Brikama Market indicated 20 vegetable vendors with at least 5 pieces of vegetables decaying, market sales decline by approximately 5 kg for every transaction. This study aims to determine the effectiveness of organic waste treatment using EM4 and LOM. This research is purely experimental, uses Posttest Group design and Independent Sample T-Test. This research was conducted in groups, with different forms of waste-treatments which included the use of EM4 and local microorganism activators and observed as it decays. The results obtained differences in the average processing of organic waste using EM4 and LOM activators. The average temperature of EM4 activator 29.89˚C while LOM 29.97˚C. The average humidity 48.67 for EM4 activator while LOM 49.64 and the average pH of EM4 activator 5.96 while LOM 5.43. The research revealed significant changes in EM4 and LOM activators seen from the measurement of temperature, humidity and pH. It is recommended to the community to participate in managing waste, especially organic waste by making compost using EM4 and LOM activators.

1. Introduction

Waste according to Jassey et al., is something that is not used, not intended to be used, disliked, intended to be thrown away or something that is thrown away that comes from human activities and does not happen by itself [1]. The research conducted by Wang et al. [2] on renewable hydrogen production from municipal solid waste. The results of the study concluded that composting of various types organic waste has shown differently the effectiveness of the composting process. Composting is purely conducted on organic waste matter. It has been proven significantly reduce the volume inside country and provide solutions for agriculture as a substitute for fertilizer chemical fertilizers. This also has a similar findings with that of [3].

Other studies conducted by Kohlstock and Kraft [4] in the European Union found that organic waste that was converted into compost could be very beneficial for farmers. The process of recycling organic waste provides economic benefits for the community to mobilize unused waste.

Data from the environment unit of Brikama Area Council states that the estimated comparison data from 2017-2021, lagging waste produced in various places, namely Brikama Town 314,225.00m³/day,

Farato Village 177,004.00 m³/day, Busumballa with 37,403.55 m³/Day, Kitty Village with a waste volume of 10,115.50 m³/day, and Kembujeh area with a waste volume of 2,901.00 m³/day [5). Waste from Brikama town is produced by many housing as many as 218.90 m³ and from market waste as much as 72.96 m³ from 446.27 m³ of waste/day, the average domestic waste generation of Brikama Town is 1.49 liters/person/day [5].

Waste management by sorting waste according to its type is actually going well, but the lack of community knowledge of organic waste management makes this waste management not to proceed effectively so that there is a lot of build-up of organic waste [1,6].

Organic waste can be processed into fertilizer using fermentation process. Organic fertilizer made using the fermentation process is called compost. Making compost in a conventional way takes a long time so it is less effective for overcoming the problem of build-up of organic waste. In order to solve the issue, it is required to identify alternative or more efficient composting techniques. [4,7,8].

Compost is the result of weathering process of organic materials due to the interaction between decomposing microorganisms that work in it. Compost is also one type of organic fertilizer because it comes from weathered organic matter.

LOM is a fermented microorganism of the material in the surrounding environment and is easy to obtain. The use of raw materials is adjusted to the potential in a region. LOM contains elements of micro and macro nutrients and microbes, the LOM solution has the potential to overhaul the organic matter, stimulant growth and disease control agents and plant pests [8]. LOM that works requires carbohydrate intake as a source of energy. Carbohydrates can be obtained from rice laundry water, where on the skin of rice there is a high carbohydrate content. When washing, the carbohydrate will dissolve in the washing water. The carbohydrate content contained in rice washing water can be used as a source of food suppliers for microorganisms [7,8].

LOM can be used as organic fertilizers, as decomposer or the culprit of making compost fertilizer and as natural occurring pesticides. According to the results of the study, giving LOM as organic fertilizer/LOM is able to fertilize red spinach plants [3,9].

EM4 can accelerate the composting process; the addition of EM4 can eliminate the odour that arises during the composting process if the composting process takes place smoothly EM4 solution is a bioactivator used to make compost in solid form called bokashi. Organic materials commonly composted are vegetables, grass, husks, sawdust [2]. Compost activator that is easily found is EM4. According to review of data, [5,6,10] the advantage of the EM4 included the composting time of 4-7 days, the resulting compost is not hot, it does not smell foul and does not contain pests and diseases [11,12]. The increasing level of compost waste that could have been used as manure because of its high content of micro and macro nutrients important for plant growth is not fully utilized. The basis of this study is to determine the effectiveness of organic waste treatment using EM4 and LOM. Which of the two methods is more effective and saves time while causing lesser harm to the environment.

2. Methodology

This study is purely experimental research where the researcher aimed at looking for the effectiveness of both EM4 and LOM activators in organic waste processing. This study was conducted in ten groups, with different forms of treatment.

The 10 groups were selected by the researchers at every 20 meters of the market. Waste samples were collected, processed and treated. The results of the samples were observed for composting in the time frame of 4-7 days.

The resulting temperatures were also read to see if the temperature increases or not, see of it has developed some form of foul smell as it should under normal circumstances. It was also observed for the presence of pests and substances that might disturb the growth pattern of the plant. This study used a posttest group design. This design allowed the researchers to measure the effect of waste treatment (intervention) on the experimental group by comparing the results of the various groups. The research was conducted in the Brikama market in the west coast region of The Gambia from February-April 2022.

3. Result and Discussion

This study examines the effectiveness of using EM4 and LOM in organic waste processing in Brikama market.

3.1. Univariate Analysis

Univariate analysis was carried out to describe the distribution of each research variable:

3.1.1. Average Composting Temperature by Using Activator EM4. Based on table 1 the average composting temperature using EM4 activator is 29.89˚C with standard deviation 1.31. The researcher's assumptions on compost temperature using EM4 activator is that I was supposed to be close to soil temperature, which ranges from 28-50˚C where the average EM4 compost temperature 29.89˚C. Temperature at the end of compost according to the Gambian National Standards (GNS) should not exceed 30˚C.

Table 1. Average Composting Temperature By Using Activator EM4

Variable	Mean	SD	Min Temp (˚C)	Max Temp (˚C)
Temperature of EM4	29.89	1.31	24	31

*SD: Standard Deviation, Min: Minimum, Max: Maximum

3.1.2. Average Composting Temperature by Using LOM. Based on table 2 it is known that the average composting temperature using LOM is 29.97 with a standard deviation of 1.24. According to the researcher's assumptions, on compost waste temperature comparing to the results of LOM already approaching the temperature of ground soil that ranges from 28-50˚C where the average LOM temperature is 29.97˚C. Final temperature of compost according to GNS should not exceed 30˚C.

Table 2. Average Composting Temperature Using LOM

Variable	Mean	SD	Min Temp (˚C)	Max Temp (˚C)
Temperature of LOM	29.97	1.24	25	31

*SD: Standard Deviation, Min: Minimum, Max: Maximum

3.1.3. Average humidity of compost EM4 activator is used. Based on Table 3 it is known average composting humidity by using activator EM4 is 48.67 by standard deviation of 2.41. According to the researcher's assumptions, on the results of moisture research compost with EM4 activator where is the mean humidity EM4 48.67 while according to GNS 22-1012-2014 max limit compost moisture is 50% so the results of the terms of composting meet specifications compost from organic matter.

Table. 3 Average humidity of compost using EM4 as the activator

Variable	Mean	SD	Min Humidity	Max Humidity
Humidity EM4	48.67	2.41	44	53

*SD: Standard Deviation, Min: Minimum, Max: Maximum

3.1.4. Average Humidity Composting Using LOM. Based on Table 4 it is known average composting humidity using LOM is 49.64 with a standard deviation of 2.53. According to the researcher's assumptions, on the results of moisture research compost with LOM where the average humidity LOM 49.64 while according GNS 22-1012-2014 maximum humidity limit of compost is 50% so the result of the condition composting meets the requirements Compost specifications of materials organic.

Table 4. Average Humidity Composting With Using LOM

Variable	Mean	SD	Min Humidity	Max Humidity
Humidity LOM	49.64	2.53	43	52

*SD: Standard Deviation, Min: Minimum, Max: Maximum

3.1.5. Average pH of Composting using EM4 Activators. Based on Table 5 it is known average pH of composting with using EM4 activator 5.96 with a standard deviation of 0.71. According to the researcher's assumptions, on the results of research on compost pH with EM4 and LOM activators where the average is 5.96. pH that meet the requirements, namely the pH is close to neutral pH.

Table 5. Average pH Of Compost using EM4 Activators

Variable	Mean	SD	Min pH	Max pH
pH EM4	5.96	0.71	4	6

*SD: Standard Deviation, Min: Minimum, Max: Maximum

3.1.6. Average pH of composting using LOM. Based on table 6, it is known that the average pH of composting with using a LOM of 5.43 with a standard deviation of 0.85. According to the researcher's assumptions, the results of the research on the pH of compost using LOM where the average LOM pH is 5.43. LOM pH is smaller than EM4 pH. The pH that meets the requirements is a pH that is close to neutral pH.

Table 6. Average humidity of composting using LOM

Variable	Mean	SD	Min pH	Max pH
pH LOM	5.43	0.85	4	8

*SD: Standard Deviation, Min: Minimum, Max: Maximum

3.2. Bivariate Analysis

Based on bivariate analysis that the researchers conducted with the title the effectiveness of organic waste processing using EM4 and LOM activators, using the Independent sample t-test statistical test as follows:

3.2.1. Composting temperature effectiveness using EM4 and LOM activators. Based on Table 7, it is known that the average composting temperature using EM4 activator was 29.89˚C with a standard deviation of 1.31 while the average composting temperature using LOM is 29.97˚C with a standard deviation of 1.24. The difference between the two variables is 0.50. Statistical test results obtained p value 0.39 at (α) 0.05 meaning Hypothesis (o) is accepted which means that there is no difference between the EM4 temperature and the LOM temperature. According to the research, the results showed that the temperature of the compost with EM4 activator and LOM was close to the soil temperature, which ranged from 28-50˚C, where the average temperature of EM4 compost was 29.89˚C, and the LOM temperature was 29.97˚C. The final temperature of compost according to GNS should not exceed 30˚C. Compost temperatures EM4 and LOM are equally effective, both composts are equally good and both composts can be used [12,13]. So waste processing is more effective using EM4 activator (14). The

length of time for composting using EM4 activator is 15 days and the length of time for composting using LOM is. The length of time for composting is faster than using EM4 [14,15].

3.2.2. Humidity effectiveness using EM4 and LOM activators. Based on table 8, it is known that the average humidity of composting using EM4 activator is 48.67 with a standard deviation of 2.41 while the average humidity of composting using LOM is 49.64 with a standard deviation of 2.53. There is no significant difference between mean deviations of the two variables which is 0.851 and 0.852. Statistical test results obtained p value of 0.37 at 0.05 (α) means Ho is accepted which means that there is no difference between EM4 humidity and LOM humidity. According to the researcher's assumptions [13,14,15], the results of the research on compost moisture using EM4 and LOM activators where the average humidity of EM4 is 48.79 and LOM humidity is 49.64. The more effective humidity is LOM humidity because it is close to the maximum moisture limit in compost and humidity at EM4 is also good [6,16]. Meanwhile, according to GNS 22-1012-2014 the maximum limit of compost moisture is 50%, so the results of the composting requirements meet the specifications for compost from organic matter. The length of time for composting using EM4 activator is 15 days and the length of time for composting using LOM is 19. The length of time for composting based on this experiment is faster than using EM4.

Table 8. Humidity effectiveness of composting with EM4 and LOM activators

Variable	Mean	SD	MD	P-Value
EM4 Humidity	48.67	2.41	0.85	0.37
LOM Humidity	49.64	2.53	0.85	0.38

*SD: Standard Deviation, MD: Mean Deviation.

3.2.3. Effectiveness of pH using EM4 and LOM activator. Based on Table 9, it is known that the average pH of composting using EM4 activator is 5.96 with a score of standard deviation of 0.71 while the average pH of composting using LOM is 5.43 with a standard deviation of 0.85. The difference between the two variables is just 0.53. Statistical test results obtained p value 0.50 at 0.05 (α) means Ho is accepted which means that there is no difference between pH, EM4 and pH LOM. According to the researcher's assumptions, the results of the research are the pH of compost with EM4 and LOM activators where the average is 5.96 and the pH using LOM is 5.43. A more effective pH is the pH of composting using EM4 because the pH is closer to normal pH. The pH that meets the requirements is a pH that is close to neutral pH, so pH EM4 is better than pH LOM so it is more effective to use EM4 and both are equally effective and good for use as compost [13,17]. The length of time for composting using EM4 activator is 15 days and the length of time for composting using LOM is 19. The length of time for composting is faster than using EM4 based on this experiment. This finding is on contrast with the literature review conducted by Anderson et al in 2018 and Puccetti et al in 2021 [18,19] which stated otherwise using PM4 to control the and minimise the pH of organic waste in healthcare setting. When the same test was conducted using vegetables by Mirwandono and co [20], the results match that of the experiment

Table 9. Effectiveness of pH using EM4 and LOM

Variable	Mean	SD	MD	P-Value
EM4 pH	5.96	0.71	0.50	0.10
LOM pH	5.43	0.85	0.51	0.11

*SD: Standard Deviation, MD: Mean Deviation.

4. Conclusions

The average temperature of compost using EM4 activator is 29.89˚C. The average temperature of composting using LOM is 29.97˚C. The average moisture content of compost using EM4 activator is

48.67. The average humidity of composting using LOM is 49.64. The average pH of compost using EM4 activator is 5.96. The average pH of composting using LOM is 5.43.

The effectiveness of temperature using EM4 activator is 29.89˚C and LOM 29.97˚C. Meaning the most effective among the two is EM4 in terms of temperature. The effectiveness of humidity using EM4 is 48.67 and using LOM is 49.64. Therefore, it can be concluded that LOM is more effective in terms of moisture accumulation. The effectiveness of pH using EM4 activator is 5.93 and that using LOM is 5.43. The most effective among the two in terms of pH is EM4.

This research finally concludes that local organic microorganisms are very good in moisture keeping in compost. The acidity level and the alkalinity level are best controlled using the EM4. Therefore, it is the most ideal processing method.

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Bibliometric Analysis of Thermal Comfort and Sleep Quality Research Trends in Indonesia

Bibliometric Analysis of Thermal Comfort and Sleep Quality Research Trends in Indonesia

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Abstract. Using a bibliometric analysis of the publication output associated with research on thermal comfort and sleep quality in Indonesia during the ten-year period 2012–2022, the purpose of this study was to describe current trends and future research areas. The database Scopus was queried for information covering the years 2012 to 2022. We analyzed selected documents containing "thermal comfort," "Indonesia," and "sleep quality" as part of the title, abstract, or key words and reported the following parameters: publication output trends, cooccurrence, author institution, author key words, and index key words. We utilized Visualization of Similarities (VOS) viewer to analyze the files of a bibliographic database in which five co-occurrences occurred. Air conditioning, ventilation, and the tropics accounted for three main cluster of thermal comfort in Indonesia. Meanwhile, in the sleep quality, the main cluster consisted of human, adult, and major clinical study. This study provides a bibliometric analysis demonstrating that, over the past 26 years, the annual number of publications pertaining to sleep quality in Indonesia has increased at a significantly faster rate than literature on thermal comfort. The latest keywords (trend) of thermal comfort are energy efficiency, temperature effect, and field measurement. In the sleep quality topic, the latest keywords are pandemic, controlled study, and Pittsburgh Sleep Quality Index (PSQI).

1. Introduction

Sleep is primarily a behavior. The identification and classification of sleep was based on changes in posture, continued behavior throughout sleep, and an enhanced arousal threshold [1]. A third of the day is devoted to sleep [2], which is an essential daily activity for maintaining good health [3]. A quality night's sleep allows the body to recuperate and prepares them for the day ahead. Sleep is necessary for relieving physical and psychological exhaustion [4], enhancing work performance, and preserving wellness at both school and work [5]. During a typical sleep time, a person has four to six sleep cycles [6]. A newborn requires 12–18 hours of sleep. Between the ages of 5 and 10, children have a 10-hour sleep demand. As teenagers need around 8 and 9 hours while adults need around 7 and 8 hours, the

demand lowers further [7]. Quantity and quality of sleep are distinct concepts. Sleep quantity is defined by how long a person sleeps each night, whereas sleep quality is influenced by how thoroughly a person sleeps. Taking the effort to analyze your sleep quantity will allow you to quickly determine whether or not you are sleeping enough each night. As a general rule, high sleep quality is identified by the following properties: rapid onset of sleep, fewer awakenings, sleep duration commensurate with age recommendations [4], rapid re-entry into sleep, and morning clarity. Alternately, Rehman (2021) concluded that a number of factors could be leading to poor sleep quality [8].

Some research suggests that getting too little sleep can be harmful to your health, and that getting too much sleep might be just as harmful [9]. Thirty-five percent of American adults say they get less than seven hours of sleep per night on a regular basis [10]. Insomnia (30-48% of adults [11] ; women get a 40% higher mortality rate of insomnia than men [12]); obstructive sleep apnea or OSA (15-30% of males [13] and 10-30% of females [14] suffer OSA; 2-9% of adults in the USA suffer OSA); central sleep apnea or CSA; restless leg syndrome; narcolepsy; teeth grinding; talking in sleep; sleep walking Multiple medical effects, including high blood pressure, right ventricular hypertrophy, arrhythmia, and other irregular cardiac rhythms, as well as ischemic heart disease and cerebrovascular dementia [15], have been linked to sleep apnea [15].

Sleep deprivation, reduced attention and judgment, lower work efficiency, and diminished physical strength all diminish life quality and contribute to serious accidents. Moreover, sleep disruptions affect immunological function, biological defense, and maintenance processes [16]. The people may be ignorant of the loss in job productivity induced by sleepiness, which increases the likelihood of incidents and human mistake [5]. Numerous prior studies on indoor thermal conditions, particularly the microenvironment (such as the sleeping space or bedroom), have shown that maintaining a pleasant temperature is essential for sleep quality [17]–[19]. Seasonal variations in interior temperature may have variable effects on sleep measurements. During the summer, there was a considerable association between the inside and outdoor temperatures, however during the cooler months, the correlation was weaker [20].

Generally, thermal comfort is enhanced by complying to the relevant standard's recommendations. Nevertheless, thermal comfort requirements (ASHRAE 55, ISO 7730) are generally applied to all individuals, irrespective of ethnicity or nationality. In addition, physical elements including bedroom temperature, humidity, sound, light, and wind might be considered sleep quality factors. Physical elements resulting from variations in house design and physiological factors resulting from the living environment may influence the factors that affect sleep quality. For instance, there is a difference in the quantity of items in the room and the thermodynamic efficiency between the room of a person living alone in an apartment and the room of a person living alone in a house, and there may be a little difference in the setting.

In developed countries, comfort temperature studies have been extensive: comfort temperatures in workplaces [21], [22], in dwellings during the summer [23]–[25], and throughout the seasons [26]. In Indonesia, however, sleep thermal comfort research (review and empirical) is still scarce. For the purpose of describing this phenomenon, a bibliometric study was performed to determine the trend of research on thermal comfort as well as sleep quality within Indonesia. The current analysis relied on the Scopus database of scholarly literature (in last 10 years). The purpose of this study was to examine the trend of thermal comfort and sleep quality studies in Indonesia. In addition, opportunities for research topics could also be identified.

2. Method

Bibliometric analysis has been widely used in previous review-based research. However, in the thermal comfort and sleep quality is still limited. In the current study, we conducted Bibliometric Analysis to answer the research question (see Figure 1).

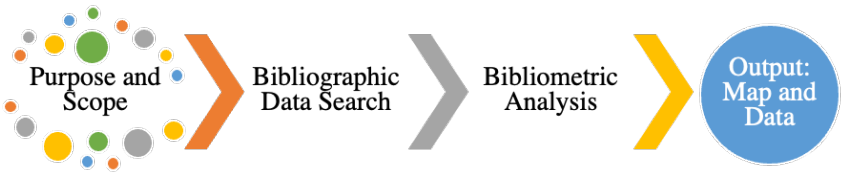


Figure 1. Bibliometric Analysis Steps

In the first step, we stated the purpose and scope of the research. The purpose was to explore the research trend of thermal comfort and sleep quality in Indonesia. Furthermore, two main scopes were approached (keywords and publication time). In the second step, we explored bibliographic data in the Scopus database. Three combinations keywords were applied in bibliographic data search, namely: (1) "thermal comfort" AND "Indonesia"; (2) "sleep quality" AND "Indonesia"; and (3) "thermal comfort" AND "sleep quality" AND "Indonesia." Searching bibliographic data was conducted within article title, abstract, and keywords. Furthermore, the selection of article studies was carried out by examining the publication time on the development of thermal comfort and sleep quality in Indonesia between 2012 and 2022. In the third step, co-occurrence analysis was applied based on keyword(s) from two or more documents. Co-occurrence analysis is intended to analyze the content, patterns and trends (trends) of a collection of documents by measuring the strength of keywords/ terms [27]. Co-occurrence analysis is performed to determine the frequency with which three keyword combinations from a research document simultaneously appear in the article under consideration. In the second step, this keyword combination is determined beforehand. The greater the frequency with which comparable keywords appear in a group of papers, the stronger their association. VOS viewer version 1.6.18 (open-source license, Centre for Science and Technology Studies (CWTS) of Leiden University, Netherlands) was applied in the current step to explore data and visualization of network. Network visualization represent the cluster that produced by VOS viewer. Number of research publication each year was analyzed by Microsoft Excel for Mac version 16.59 (Microsoft 365 Subscription, Microsoft, Redmond-United State).

3. Results and Discussions

The growth of publications on the topic of thermal comfort and sleep quality in Indonesia has increased significantly in 2018-2021. As seen in table 1 and figure 1, the number of publications in 2021 reached 21% (out of 135 publications) on thermal comfort topic and 27% (out of 90 publications) on sleep quality topic. In the thermal comfort topic, the documents type is dominated by conference paper (47.4 %), article (39.3 %), and conference review (5.9 %). Institut Teknologi Bandung (17 documents) was the most published article in thermal comfort topic, followed by Universitas Indonesia (13 documents) and Institut Teknologi Sepuluh Nopember (12 documents). In the sleep quality topic, the documents type is dominated by article (92.2 %), conference paper (5.6 %), and conference review (1.1 %). Universitas Indonesia (46 documents) was the most published article in sleep quality topic, followed by Universitas Airlangga (9 documents) and Universitas Gajah Mada (5 documents).

Table 1. Number and percentage publication by year.

Year	TC (f)	TC (%)	SQ (f)	SQ (%)
2012	3	2	1	1
2013	3	2	0	0
2014	3	2	2	2
2015	10	7	1	1
2016	6	4	2	2
2017	13	10	2	2

2018	27	20	11	12
2019	16	12	21	23
2020	16	12	16	18
2021	28	21	24	27
2022	10	7	10	11
Total	135	100	90	100

Abbreviations: TC (f), frequency of thermal comfort; TC (%), percentage of thermal comfort; SQ (f), frequency of sleep quality; SQ (%), percentage of sleep quality.

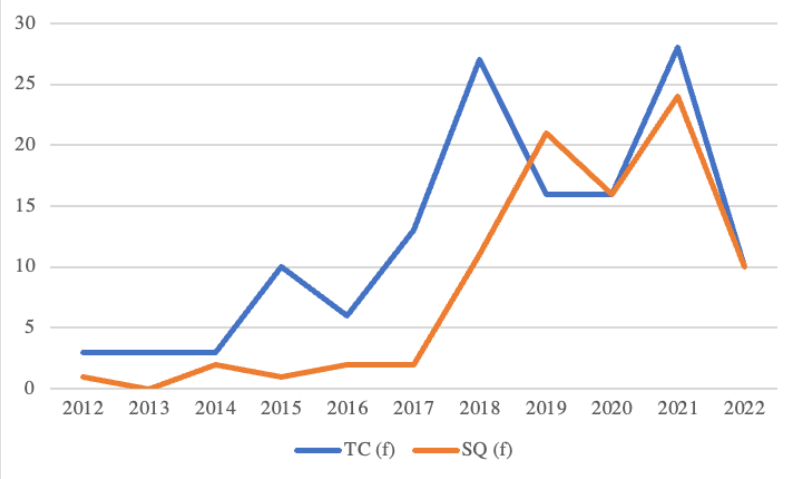
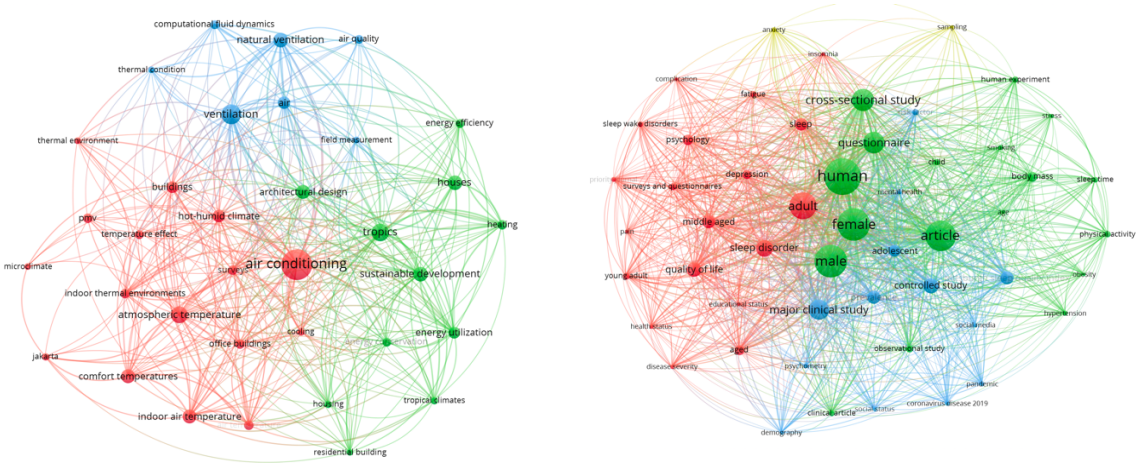


Figure 2. Trend of publication by year.

Abbreviations: TC (f), frequency of thermal comfort; SQ (f), frequency of sleep quality.

Figure 3(a) showed that based on keywords ("thermal comfort" AND "Indonesia"), co-occurrence map of thermal comfort consisted of three clusters. Cluster 1 with red color consisted of 16 keywords: air conditioning, air temperature, atmospheric temperature, buildings, comfort temperatures, buildings, comfort temperatures, cooling, hot-humid climate, indoor air temperature, indoor thermal environment, Jakarta, microclimate, office buildings, PMV, surveys, temperature effect, and thermal environment. Cluster 2 with green color consisted of 11 keywords: architectural design, energy conservation, energy efficiency, energy utilization, heating, houses, housing, residential building, sustainable development, tropical climates, and tropics. Cluster 3 with blue color consisted of 7 keywords: air, air quality, computational fluid dynamics, field measurement, natural ventilation, thermal condition, and ventilation. Figure 3(b) showed that based on keywords ("sleep quality" AND "Indonesia"), co-occurrence map of sleep quality consisted of four clusters. Cluster 1 with red color consisted of 19 keywords: adult, aged, complication, depression, disease severity, educational status, fatigue, health status, insomnia, middle aged, pain, priority journal, psychology, quality of life, sleep, sleep disorder, sleep wake disorders, survey and questionnaire, and young adult. Cluster 2 with green color consisted of 18 keywords: age, article, body mass, child, clinical article, cross-sectional study, female, human, human experiment, hypertension, male, obesity, observational study, physical activity, questionnaire, sleep time, smoking, and stress. Cluster 3 with blue color consisted of 13 keywords: adolescent, controlled study, coronavirus disease 2019, demography, major clinical study, mental health, pandemic, Pittsburgh sleep quality index, prevalence, psychometry, risk factor, social media, and social status. Cluster 4 with yellow color consisted of two keywords: anxiety, and sampling.



(a) (b)

Figure 3. Co-Occurrence Map of (a) Thermal Comfort; (b) Sleep Quality

Based on a map of two keywords combinations (Figure 3: "thermal comfort" AND "Indonesia", and "sleep quality" AND "Indonesia"), thermal comfort and sleep quality were not related to each other. Furthermore, by combining the two combinations of keywords ("thermal comfort" AND "sleep quality" AND "Indonesia"), the data search results were also nil. Even though previous research has stated that thermal comfort is essential to maintaining and improving sleep quality [17]–[19]. Indonesia, which is located on the equator line, has a tropical climate and with a dry and rainy season. Indonesia receives roughly 12 hours of sunlight per day with the average temperature same throughout year (21.4 - 28.7 °C) [28]. This may indicate that thermal comfort has not been sufficiently considered in relation to sleep quality. In the future, however, with the emergence of the phenomenon of global warming, the study of thermal comfort and sleep quality will be crucial.

4. Conclusion

The highest frequency publication between 2012 and 2022 was 28 (21%) publications for thermal comfort and 24 (27%) publications for sleep quality. The document type dominated by conference article for thermal comfort and article for sleep quality. Furthermore, analysis found the latest keywords (year: 2022) of thermal comfort and sleep quality topic. The latest keywords (trend) of thermal comfort are energy efficiency, temperature effect, and field measurement. In the sleep quality topic, the latest keywords are pandemic, controlled study, and Pittsburgh Sleep Quality Index (PSQI). In sleep quality studies, thermal comfort has not been accounted for. With the emergence of the phenomenon of global warming, it will be fascinating to further investigate the relationship between thermal comfort and sleep quality.

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