ISSN No:-2456-2165

Analysis of Strategic Selection to Settlement Conflicting Interests Caused by Noise Intensity in the Workplace with Soft System Base Multi-Methodology Approach: A Case Study in a Manufacturing Company

Mochamad Eko Nugroho, Muhammad Zuhdi Prasetyo Nugroho, Yogy Yayang Saputra, Erry Rimawan
Master of Industrial Engineering Program, Mercu Buana University, Jakarta, Indonesia

Abstract:- Noise is a sound or sound that is not desired and can interfere with health, comfort and can cause deafness. The current condition of many factories is established outside the industrial area, where the plant is in the position of neighborhood residents. From these conditions, there will certainly be many conflicting interests. The company wants high productivity by optimizing all the elements it has up to 24 hours, in this case, is for crushing the engine. Residents have an interest so that the quality of rest is as much as possible. From this clash of interests, there are many demands from the surrounding community regarding compensation that must be given by the company. While the company adheres to internal regulations that have been standardized globally. Therefore, this study aims to select the right strategy to overcome the problem, and measure the success rate of the strategy to minimize noise by the company using the soft system methodology (SSM) approach and the selection of the right strategy that must be done immediately with an analysis of the Process Hierarchy so that the correct results must be obtained as soon as possible using the Fuzzy method. The results are obtained that the Company, local government, and company have each different goal, but the main objectives must be obtained, Hence Fuzzy AHP model is utilized to solve the main selection problem of purpose criteria and alternative, which should determine the immediate action plan among 6 alternatives. As a result of the case study, the main priority variable is the creation of environmental security and prioritizing the distribution of CSR funds to the nearest environment as the first alternative that must be done immediately.

Keyword:- *Noise, Soft System Methodology Analytic Hierarchy Process (AHP), Fuzzy.*

I. INTRODUCTION

PT ABCDEF is one of the Global companies established outside the industrial estate, more precisely located adjacent to the indigenous population area. But along with the development of the environment, the company is in the middle of a residential area so that many interests of the company and the surrounding communities are conflicting. The company strives to minimize disposal costs for assembly items made of plastic so that a crusher room is built for the process. However, due to the optimal factory layout conditions, the room crusher is positioned outside the company's main building. Engine vibration and the sound dissipation process produce very loud and noisy sounds. Safety standards for workers are very well considered and applied(Sunal, et al., 2011). Noisy in occupational health, noise is interpreted as a sound that can reduce hearingboth quantitatively (increased hearing threshold) and qualitative (narrowing of the auditory spectrum0 is related to the factor of intensity, frequency, duration and time pattern(Kearney, et al., 2017).

After 2 years of operation, the crushing machine appeared various problems both internally and externally, but the biggest problem was demonstrations from surrounding communities who felt disturbed by the noise. The public wants some compensation that is contrary to the internal rules of the company that is adopted globally.Seeing the noise problems that occur, this research was conducted with the aim to determine the right strategy to overcome the problem. The research will be conducted at the ABCDEF Company. The method used is Soft System Methodology, which is usually abbreviated as SSM, which is a system-based approach that is commonly used to solve various problems, especially problems that have not been or are not clearly structured(van de Water, et al., 2007; Booton, 2018; Bernardo, et al., 2018).Based on several criteria and alternatives considered, several decision-making methods have been proposed to provide solutions to this problem.Because uncertainty and ambiguity of the opinions of experts is a prominent characteristic of the problem, the inaccuracy of human judgment can be handled through fuzzy

ISSN No:-2456-2165

set theory developed by Fuzzy AHP method to systematically solve selection problems using fuzzy set theory concepts and hierarchical structure analysis (Yu & Hou, 2016; Patil, 2018; Hsu, et al., 2014; Chen, et al., 2018).

II. LITERATURE REVIEW

According to Flood (2010), Soft system methodology was introduced by Peter Checkland at Lancaster University, England in 1981. SSM began to be developed with the aim of overcoming problems that arise from human activities. According to Maqsood (2001), SSM is a framework for solving problems that are difficult to define or not well structured. According to Warwick (2008), Soft Systems Methodology places an emphasis on human activity systems i.e. humans involved in purposeful activity within an organization of some sort. The methodology provides a window through which the complexity of such human interaction can be investigated, described and hopefully understood. Once an understanding of the situation under study has been achieved then the methodology allows the identification of change that is both systemically desirable (in that it will alleviate some of the problems and issues) and culturally feasible (in that actors within the system will be inclined to engage with the changes proposed and the change process itself). SSM encourages understanding and learning that is expected to lead to agreed changes and problem-solving. System thinking is based on two pairs of ideas: communication and control as one pair, and emergence and hierarchy as the other (Checkland, 1981; Checkland & Poulter, 2006).

According to Warwick (2008), since SSM was introduced in 1981, this method continued to develop until 1990. During this period, SSM has undergone a number of revisions and modifications, but the most commonly used models remain original models consisting of seven stages. Checkland and Scholes (1990) emphasize that the seven stages carried out in SSM are not rigid, so that in practice the process does not always have to be advanced, but can go forward or backward at each stage(Checkland, 2000). Seven stages of SSM according to Checkland and Scholes (1990) are: stage 1; Review unstructured problems then stage 2; State the problem situation continued in step 3; Determine the component of the problem in system activity after that stage 4; Build the conceptual model then stage 5; Compare the conceptual model with the problem situation then stage 6; Make appropriate and desired changes and the last stage 7; Make corrective action on the problem.

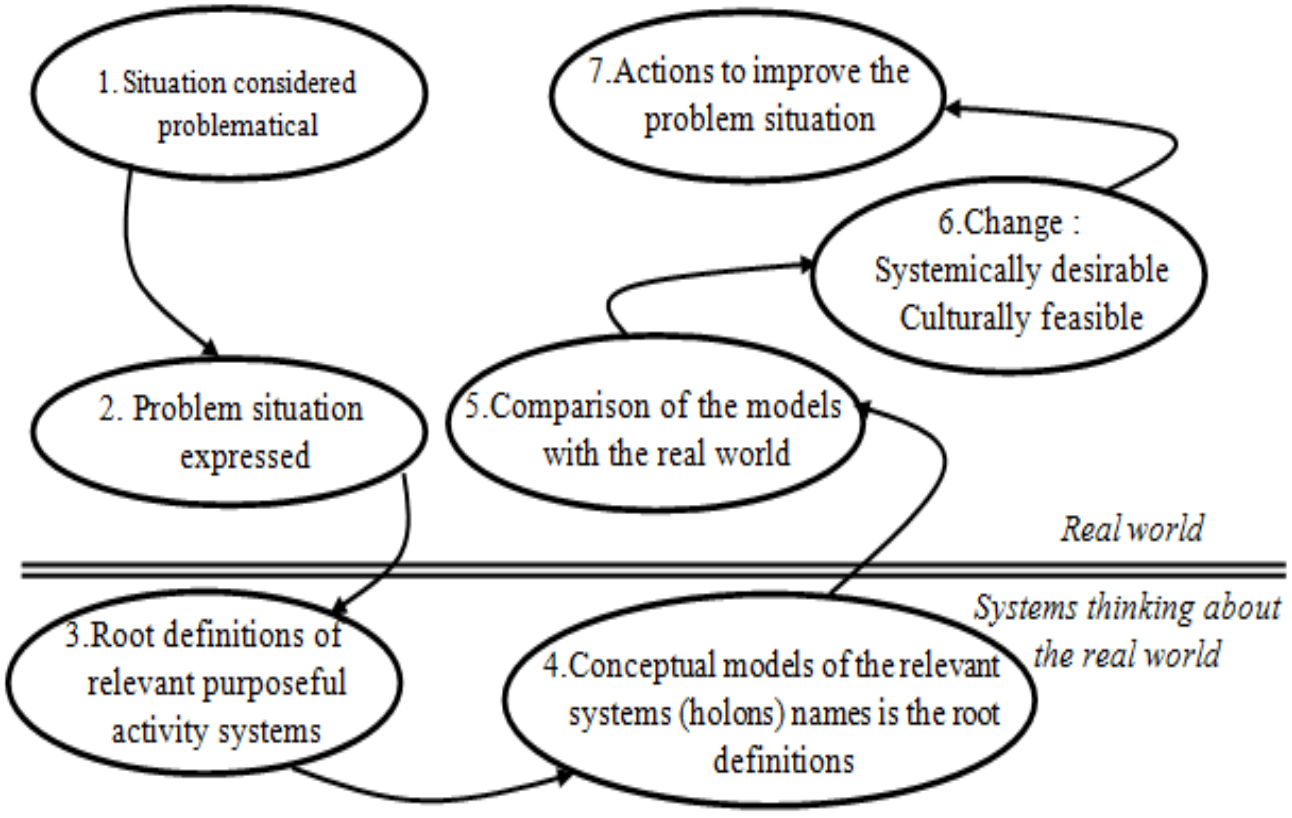

Fig 1:- The Steps of SSM(Checkland, 1981).

ISSN No:-2456-2165

Root Definition – CATWOE

C *Client* – the immediate beneficiaries or victims of the system results.
A *Actors* – the participants in the transformation, i.e. those who carry out activities within the system.
T *Transformation* – the core of the human activity system, in which some inputs are converted into outputs and given to the clients. Actors play a role in this transformation process.
W *Weltanschauung* (world view) – the perspective or point of view that makes sense of the root definition being developed.
O *Owner* – the individual or group responsible for the proposed system. He/she has the power to modify or even stop the system, overlapping other system actors.
E *Environmental constraints* – the human activity systems work under some constraints imposed by the external environment, as legal, physical or ethical constraints.

The noise that occurs in the environment usually consists of sound signals with a broad spectrum (Salomons & Janssen, 2011). According to Smith (2003), a large number of studies conducted have shown a strong relationship between noise sensitivity and negative effectiveness or the degree to which individuals perceive or report negative features of the environment or themselves. So, noise can be defined as an unwanted sound and that causes pain, or that blocks lifestyle (JIS Z 8106, IEC60050-801).

To improve clarity about personal valuation in basic AHP, it is necessary to use the fuzzy logic approach (Ma, et al., 2010). In F-AHP, pairwise comparisons of both criteria and alternatives are carried out through linguistic variables, which are represented by triangle numbers (Safari, et al., 2014). They define triangle membership functions for pairwise comparisons (Bayer & Karamaşa, 2018). According to Kordi (2008), the subject by determining the ratio of fuzzy priorities that have a triangle membership function has been contributed by Buckley (1985). The new method related to the use of triangle numbers in pair-wise comparisons was also introduced by Chang (1996).

According to Ayhan (2013), there are several techniques embedded in F-AHP. This study will implement the Buckley method to determine the weight of relative importance for criteria and alternatives. The procedure steps are as follows:

Step 1: Decision Maker compares the criteria or alternatives via linguistic terms shown in table 1.

Saaty Scale	Definition	Fuzzy Triangular Scale
1	Equally important (Eq. Imp.)	(1, 1, 1)
3	Weakly important (W. Imp.)	(2, 3, 4)
5	Fairly important (F. Imp)	(4, 5, 6)
7	Strongly important (S. Imp.)	(6, 7, 8)
9	Absolutely important (A. Imp.)	(9, 9, 9)
2	The intermittent value between two adjacent scales	(1, 2, 3)
4		(3, 4, 5)
6		(5, 6, 7)
8		(7, 8, 9)

Table1:- Saaty scale Definition Fuzzy Triangular Scale

Base on the corresponding triangular fuzzy numbers of these linguistic terms, for example, if the decision maker states "Criterion 1 (C1) is Fairly Important than Criterion 2 (C2)", then it takes the fuzzy triangular scale as (4, 5, 6). On the contrary, in the pairwise contribution matrices of the criteria, comparison of C2 to C1 will take the fuzzy triangular scale as (1/6, 1/5, 1/4).

$$\tilde{A}^k = \begin{bmatrix} \tilde{d}_{11}^k & \tilde{d}_{12}^k & \dots & \tilde{d}_{1n}^k \\ \tilde{d}_{21}^k & \dots & \dots & \tilde{d}_{2n}^k \\ \dots & \dots & \dots & \dots \\ \tilde{d}_{n1}^k & \tilde{d}_{n2}^k & \dots & \tilde{d}_{nn}^k \end{bmatrix} \quad (1)$$

Step 2: The preferences of each decision maker $(\tilde{d}_{ij}^k)$ are average if there is more than one decision maker.

$$\tilde{d}_{ij} = \frac{\sum_{k=1}^{K} \tilde{a}_{ij}^k}{K} \quad (2)$$

Step 3: According to averaged preferences, pairwise contribution matrix is updated

$$\tilde{A} = \begin{bmatrix} \tilde{d}_{11} & \cdots & \tilde{d}_{1n} \\ \vdots & \ddots & \vdots \\ \tilde{d}_{n1} & \cdots & \tilde{d}_{nn} \end{bmatrix} \quad (3)$$

Step 4: The geometric mean of fuzzy comparison values of each criterion is calculated

$$\tilde{r}_i = \left(\prod_{j=1}^{n} \tilde{d}_{ij} \right)^{1/n}$$

i = 1, 2, …,n (4)

Step 5: The fuzzy weights of each criterion can be found by incorporating the next 3 sub-steps.
Step 5a: Find the vector summation of each.
Step 5b: Find the (-1) power of the summation vector. Replace the fuzzy triangular number, to make it in increasing order.
Step 5c: To find the fuzzy weight of criteria, multiply each vector summation with this reverse vector.

$$\tilde{w}_i = \tilde{r}_1 \times (\tilde{r}_1 + \tilde{r}_2 + \cdots + \tilde{r}_n)^{-1}$$

$$= (lw_i, mw_i, uw_i) \quad (5)$$

Step 6: Need to de-fuzzified by Centre of area

$$M_i = \frac{lw_i + mw_i + uw_i}{3} \quad (6)$$

Step 7: Normalized non-fuzzy number

$$N_i = \frac{M_i}{\sum_{i=1}^{n} M_i} \quad (7)$$

According to these results, the alternative with the highest score is suggested to the decision maker.

III. METHODOLOGY

To build up an analyze toolbox for the case study in PT ABCDE, the linkage between theories shouldbe grounded for integrated analysis(Novani, et al., 2014).

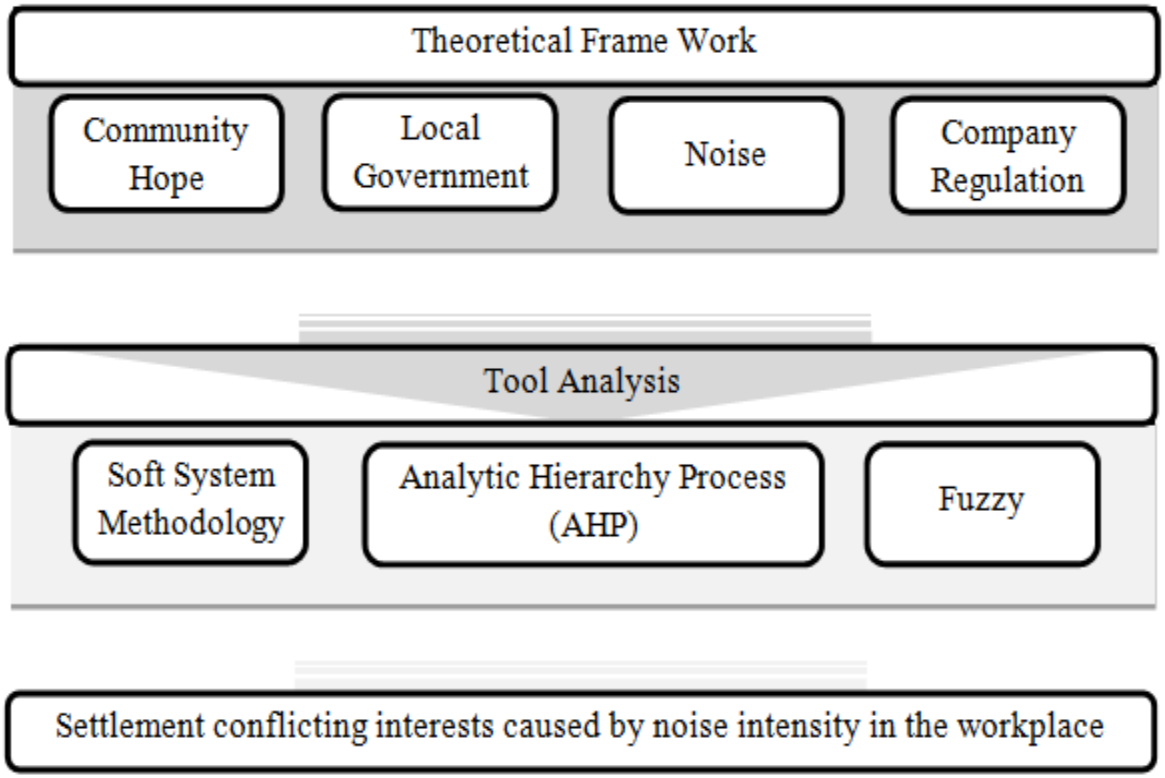

Fig 2:- Built up Analysis Toolbox

IV. RESULT AND DISCUSSION

A. Stage One - Situation Considered Problematic (Unstructured Situation)

The difference in conflict of interest between the community and the company requires a solution as a middle ground. Where the community proposes various demands based on the emotional and more towards the economy of compensation. While the company prefers the development of a clear and concrete infrastructure.

ISSN No:-2456-2165

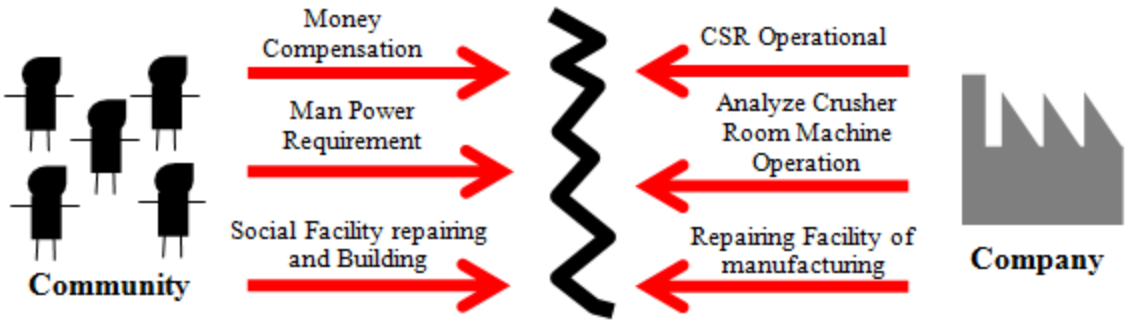

Fig 3:- Problematic

B. *Stage Two - Problem Situation Expressed*

There are several internal factors that cause noise to occur. The basis for intellectual development needed by training and education to be successful is the social and environmental concern in business.

We express the problem situation by using the rich picture as portrayed by Figure 4.

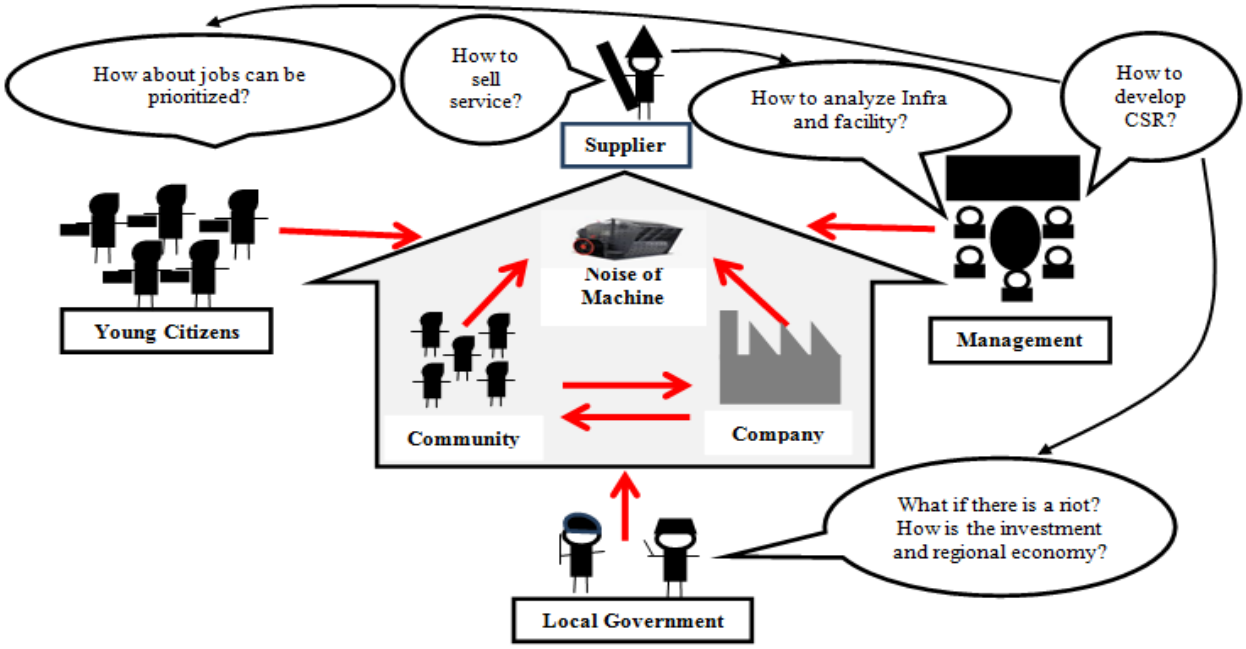

Fig.4. Rich Picture of Minimize Noise

C. *Stage Three- Root Definitions of Relevant Systems*

Based on rich images, in this stage, we develop the root definition. The root definition is as follows:

- Systems owned by communities, companies, local government and suppliers in optimizing environmental and social comfort (P)
- By finding a solution midpoint through optimization of CSR, improving infrastructure and analyzing operational sources of discomfort (Q)
- So that the noise that occurs can be minimized until there is absolutely no conflict of interest (R).

Based on the rich picture we develop CATWOE analysis as follows:

- *C (Customers):*
  Community, companies, local government, and suppliers

- *A (Actors):*
  Community, companies, and local government

- *T (Transformations)*

✓ A low capability of operational process →high capability of an operational process(crushing)
✓ High noise level → minimize noise problems

ISSN No:-2456-2165

- *W (Weltanschauung)*
  The existence of an ideal relationship between the community and the company to ensure the company's operations and the level of community interest in the quality of life are met

- *O (Owners)*
  Community and companies

- *E (Environmental constraints)*
  Companies PT ABCDE environment

D. Stage Four – Building Conceptual Model

I this Stage, we develop a preliminary a conceptual model in general as follows:

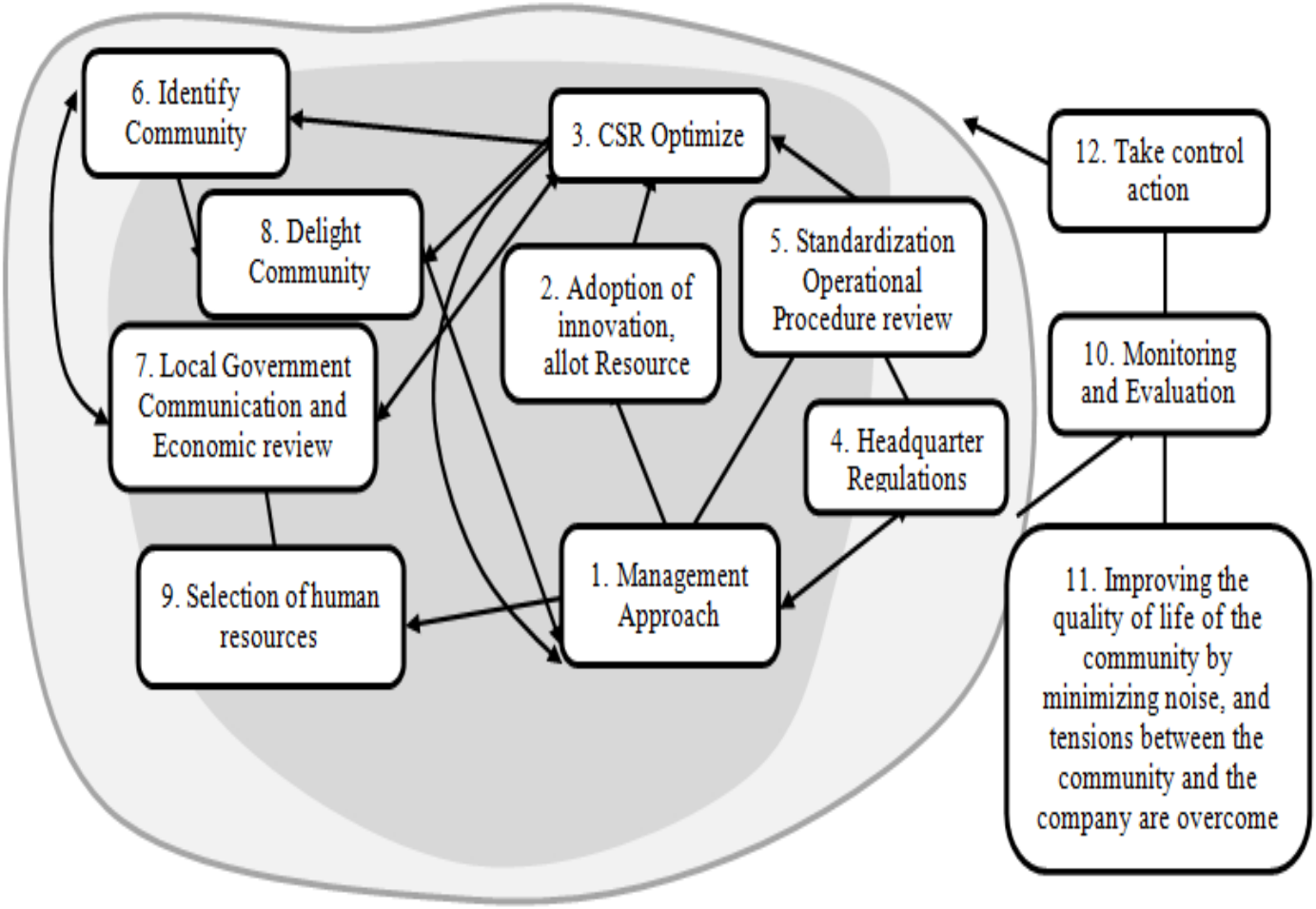

Fig 5:- Human Activity Model of Minimize Noise

E. *Stage Five and Six - Back in the Real World and Define the Changes to be Implemented*

ISSN No:-2456-2165

Conceptual Model Activity	Real world				Goal Reflection
	Terms	Devise	Action	Result	
Identify community demands due to noise that occurs	Communities within a radius that are accompanied by noise	All communities are affected both physically and psychologically	Discuss and convey the hopes of each affected community	- Health insurance - The improvement of quality of life by building social facilities	There are clear demands from affected communities (Increased Welfare, improved quality of life through fulfilled facilities and infrastructure)
Identify local government conditions for investment sustainability and regional economy	Government that plays a role in the location of the company stands	Knowledge of the industry's impact on the economy and social culture in the corporate environment	Providing direction to the public about the influence of the industry on the economy and providing knowledge of the conditions of local cultural wisdom towards the company	- Companies Prioritize operational CSR for affected communities - There is good cooperation between the company and the community by empowering young people to become workers in the company	Able to provide knowledge, insight and mediate between the interests of the community and the company (Economic stabilization and the creation of peace)
The company provides concrete actions to reduce the noise that occurs (Facility and social)	Sources of noise in the form of machines or work processes in companies and social relations	Crushing machine resources (machine, operator and standard operational procedure) and affected residents	Check engine conditions, operator operational standards, facility layout conditions, and optimize CSR programs	- Review of facility layout - Repair of engine conditions - Operational standard training procedures - Scheduling Checking environmental noise - CSR distribution is right on target	Achieving the goal of reducing noise levels by repairing noise sources without interfering with the production process

Table 2:- Comparison between Real Word and Purpose Reflection

Suggestions for solving noise problems are companies can realize all the proposed results from both the community and local government.

F. Stage Seven – Taking Action

To optimize the results in a system required a great effort and expense. In this case, the company seeks to minimize scrap material to recycle process, but on the other hand as a result of the addition of crusher machines cause noise impact on surrounding communities. Therefore, communication should be established between the two sides in order to obtain a balance to be immediately realized. The selection of the right strategy that must be done immediately with an analysis of the Process Hierarchy so that the correct results must be obtained as soon as possible using the Fuzzy method(Noh, et al., 2003).

The main frame of the analysis of strategy selection to minimize noise crushing machine can be represented as following fig. 6. Here, both the purpose criteria and the alternative weights should be calculated. Therefore, these two parts will be analyzed separately.

ISSN No:-2456-2165

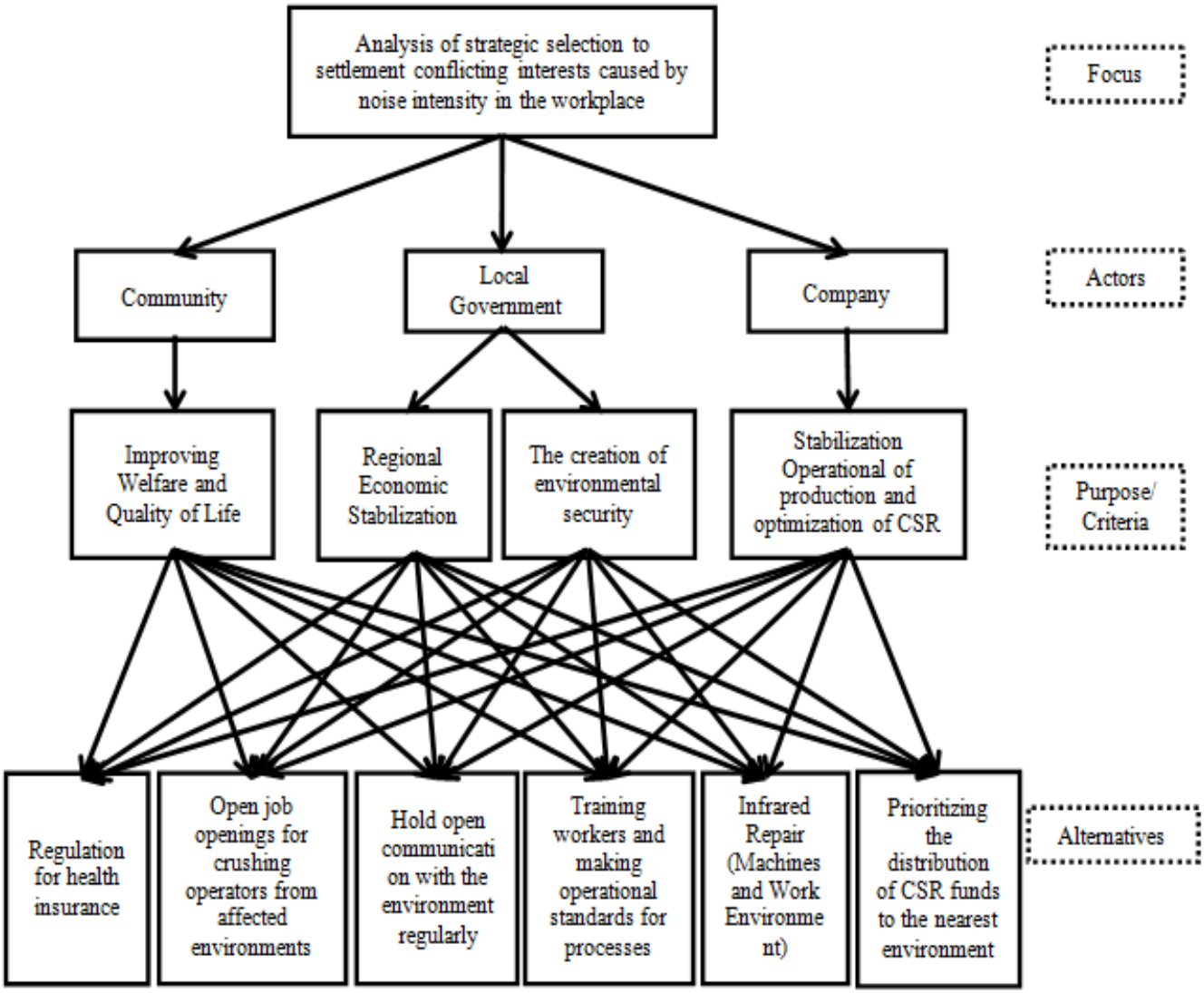

Fig 6:- The Hierarchy of the Criteria and the Alternatives

A. Values of each Criterion

- **Step 1:** Decision Maker compares the criteria or alternatives via linguistic

In order to determine the criteria and evaluate the alternatives for the action plan selection process, a meeting was performed by a community leader, local government leader, and company leader. According to their preferences, the company leader pairwise comparison of the criteria is represented by following Table 3.

ISSN No:-2456-2165

# Q	A. Imp. (9, 9, 9)	S. Imp. (6, 7, 8)	F. Imp. (4, 5, 6)	W. Imp. (2, 3, 4)	Criteria	Eq. Imp. (1, 1, 1)	Criteria	W. Imp. (2, 3, 4)	F. Imp. (4, 5, 6)	S. Imp. (6, 7, 8)	A. Imp. (9, 9, 9)
1			x		Improving Welfare and Quality of Life		Regional Economic Stabilization				
2					Improving Welfare and Quality of Life	x	The creation of environmenta l security				
3					Improving Welfare and Quality of Life		Stabilization Operational of production and optimization of CSR			x	
4					Regional Economic Stabilization		The creation of environmenta l security			x	
5					Regional Economic Stabilization		Stabilization Operational of production and optimization of CSR			x	
6					The creation of environmenta l security		Stabilization Operational of production and optimization of CSR	x			

Table 3:- Pairwise Comparisons of Criteria by Company Leader

- **Step 2:** The preferences of each decision maker are average if there is more than one decision maker.

According to Table 3, pairwise comparison matrix is formed as Table 4.

Criteria	Improving Welfare and Quality of Life	Regional Economic Stabilization	The creation of environmental security	Stabilization Operational of production and optimization of CSR
Improving Welfare and Quality of Life	(1,1,1)	(4,5,6)	(1,1,1)	(0.13,0.15,0.17)
Regional Economic Stabilization	(0.17,0.2,0.25)	(1,1,1)	(0.13,0.15,0.17)	(0.13,0.15,0.17)
The creation of environmental security	(1,1,1)	(6,7,8)	(1,1,1)	(0.25,0.34,0.25)
Stabilization Operational of production and optimization of CSR	(6,7,8)	(6,7,8)	(4,3,4)	(1,1,1)

Table 4:- Comparison Matrix for Criteria

➢ **Step 3:** According to averaged preferences, the pairwise contribution matrix is updated

Criteria	Improving Welfare and Quality of Life	Regional Economic Stabilization	The creation of environmental security	Stabilization Operational of production and optimization of CSR
Improving Welfare and Quality of Life	(1,1,1)	(1.75,2.12,2.42)	(1.05,1.39,1.73)	(2.13,2.5,2.81)
Regional Economic Stabilization	(1.72,1.4,1.75)	(1,1,1)	(0.71,0.72,0.73)	(2.71,3.39,4.06)
The creation of environmental security	(2.42,2.78,3.17)	(2.67,3,3.34)	(1,1,1)	(2.75,3.45,4.09)
Stabilization Operational of production and optimization of CSR	(3.38,3.39,4.06)	(2.12,2.47,2.84)	(1.46,1.16,1.56)	(1,1,1)

Table 5:- Average Comparison Matrix for Criteria

➢ **Step 4 and Step 5:** The geometric mean of fuzzy comparisons can be found by combining the next 3 sub-steps

In completing this methodology, after completing the first three steps than in the fourth step, look for the value of fuzzy comparison as the geometric mean of each criterion. For example, the geometric mean of the value of the fuzzy comparison criteria for "Improving Welfare and Quality of Life" is calculated as:

$$\tilde{r}_i = \left(\prod_{j=1}^{n} \tilde{d}_{ij} \right)^{1/n}$$

= [(1*1.75*1.05*2.13)$^{1/4}$ + (1*2.12*1.39*2.5)$^{1/4}$ + (1*2.42*1.73*2.81)$^{1/4}$]
= [1.41,1.65,1.85]

Thus, the geometric average data on the value of fuzzy comparisons of all criteria are shown in Table 6.

Criteria	$\tilde{r}_i$		
Improving Welfare and Quality of Life	1.41	1.65	1.85
Regional Economic Stabilization	1.35	1.36	1.51
The creation of environmental security	2.05	2.32	2.57
Stabilization Operational of production and optimization of CSR	1.80	1.77	2.06
Total	6.61	7.09	7.99
Reverse (power of -1)	0.15	0.14	0.13
Increasing Order	0.13	0.14	0.15

Table 6:- Data on Geometric Means of Fuzzy Comparison Values

In step five, the value of fuzzy weight from the criteria of "Improving Welfare and Quality of Life" is calculated as:

$\widetilde{W}_i$= [(1.41*0.13) ; (1.65*0.14) ; (1.85*0.15)]
= [0.18; 0.23 ; 0.28]

Thus, the relative fuzzy weights of each criterion are given in Table 7.

ISSN No:-2456-2165

Criteria	$\widetilde{W}_i$		
Improving Welfare and Quality of Life	0.18	0.23	0.28
Regional Economic Stabilization	0.17	0.19	0.23
The creation of environmental security	0.26	0.33	0.39
Stabilization Operational of production and optimization of CSR	0.23	0.25	0.31

Table 7:- Relative Fuzzy Weights of Each Criteria

- **Step 6 and Step 7:** Need to de-fuzzified by Centre of the area and Normalized non-fuzzy number.

In the sixth step, the relative non-fuzzy weight of each criterion (Mi) is calculated by taking theaverage of fuzzy numbers for each criterion. In the seventh step, by using non-fuzzy Mi's, the normalized weights of each criterion are calculated and tabulated in Table 8.

Criteria	Mi	Ni
Improving Welfare and Quality of Life	0.2296	0.2269
Regional Economic Stabilization	0.1964	0.1940
The creation of environmental security	0.3240	0.3202
Stabilization Operational of production and optimization of CSR	0.2620	0.2589

Table 8:- Averaged and Normalized Relative Weights of Criteria

B. Values of Each Alternative

- **Step 1:** Decision Maker compares the criteria or alternatives via linguistic

According to their preferences, the company leader pairwise comparison of the alternative is represented by following Table 9.

ISSN No:-2456-2165

# Q	A. Imp. (9, 9, 9)	S. Imp. (6, 7, 8)	F. Imp. (4, 5, 6)	W. Imp. (2, 3, 4)	Criteria	Eq. Imp. (1, 1, 1)	Criteria	W. Imp. (2, 3, 4)	F. Imp. (4, 5, 6)	S. Imp. (6, 7, 8)	A. Imp. (9, 9, 9)
1		x			Regulation for health insurance		Open job openings for crushing operators from affected environments				
2				x	Regulation for health insurance		Hold open communication with the environment regularly				
3					Regulation for health insurance		Training workers and making operational standards for processes		x		
4					Regulation for health insurance		Infrared Repair (Machines and Work Environment)			x	
5					Regulation for health insurance		Prioritizing the distribution of CSR funds to the nearest environment		x		
6					Open job openings for crushing operators from affected environments	x	Hold open communication with the environment regularly				
7					Open job openings for crushing operators from affected environments		Training workers and making operational standards for processes		x		
8					Open job openings for crushing operators from affected environments		Infrared Repair (Machines and Work Environment)			x	
9					Open job openings for crushing operators from affected environments		Prioritizing the distribution of CSR funds to the nearest environment		x		
10					Hold open communication with the environment regularly		Training workers and making operational standards for processes	x			
11					Hold open communication with the environment regularly	x	Infrared Repair (Machines and Work Environment)				
12			x		Hold open communication with the environment regularly		Prioritizing the distribution of CSR funds to the nearest environment				
13					Training workers and making operational standards for processes		Infrared Repair (Machines and Work Environment)			x	
14					Training workers and making operational standards for processes	x	Prioritizing the distribution of CSR funds to the nearest environment				
15		x			Infrared Repair (Machines and Work Environment)		Prioritizing the distribution of CSR funds to the nearest environment				

Table 9:- The Pairwise Comparisons of Alternative by Company Leader

- **Step 2:** The preferences of each decision maker are average if there is more than one decision maker.

According to Table 9, a pairwise comparison matrix is formed as Table 10.

Criteria	Regulation for health insurance	Open job openings for crushing operators from affected environments	Hold open communication with the environment regularly	Training workers and making operational standards for processes	Infrared Repair (Machines and Work Environment)	Prioritizing the distribution of CSR funds to the nearest environment
Regulation for health insurance	(1,1,1)	(6,7,8)	(2,3,4)	(0.17,0.2,0.25)	(0.13,0.15,0.17)	(0.17,0.2,0.25)
Open job openings for crushing operators from affected environments	(0.13,0.15,0.17)	(1,1,1)	(1,1,1)	(0.17,0.2,0.25)	(0.13,0.15,0.17)	(0.17,0.2,0.25)
Hold open communication with the environment regularly	(0.25,0.34,0.5)	(1,1,1)	(1,1,1)	(0.25,0.34,0.5)	(1,1,1)	(4,5,6)
Training workers and making operational standards for processes	(4,5,6)	(4,5,6)	(2,3,4)	(1,1,1)	(0.13,0.15,0.17)	(1,1,1)
Infrared Repair (Machines and Work Environment)	(6,7,8)	(6,7,8)	(1,1,1)	(6,7,8)	(1,1,1)	(6,7,8)
Prioritizing the distribution of CSR funds to the nearest environment	(4,5,6)	(4,5,6)	(0.17,0.2,0.25)	(1,1,1)	(0.13,0.15,0.17)	(1,1,1)

Table 10:- Comparison Matrix for Alternative

- **Step 3:** According to averaged preferences, the pairwise contribution matrix is updated

Criteria	Regulation for health insurance	Open job openings for crushing operators from affected environments	Hold open communication with the environment regularly	Training workers and making operational standards for processes	Infrared Repair (Machines and Work Environment)	Prioritizing the distribution of CSR funds to the nearest environment
Regulation for health insurance	(1,1,1)	(3.67,4.34,5)	(2.06,2.74,3.42)	(4.06,4.74,5.42)	(2.38,2.72,3.06)	(0.81,1.18,1.59)
Open job openings for crushing operators from affected environments	(0.44,0.45,0.48)	(1,1,1)	(1.71,2.05,2.39)	(2.39,2.74,3.09)	(2.1,2.45,2.81)	(0.44,0.45,0.48)
Hold open communication with the environment regularly	(1.48,1.85,2.25)	(2.39,2.74,3.09)	(1,1,1)	(3.42,4.12,4.84)	(2,2.34,2.67)	(1.73,2.07,2.42)
Training workers and making operational standards for processes	(1.42,1.77,2.12)	(1.71,2.05,2.39)	(0.77,1.12,1.48)	(1,1,1)	(0.16,0.19,0.23)	(0.42,0.43,0.45)
Infrared Repair (Machines and Work Environment)	(2.38,2.72,3.06)	(3.38,4.05,4.73)	(0.73,0.74,0.75)	(4.67,5.67,6.67)	(1,1,1)	(2.42,2.78,3.17)
Prioritizing the distribution of CSR funds to the nearest environment	(2.84,2.78,3.5)	(3.67,4.34,5)	(1.73,2.07,2.42)	(4.34,5,5.67)	(1.05,1.39,1.73)	(1,1,1)

Table 11:- Average Comparison Matrix for Alternative

- **Step 4 and Step 5:** The geometric mean of fuzzy comparison values of each alternative is calculated and the fuzzy weights of each alternative can be found by incorporating the next 3 sub-steps.

The geometric means of fuzzy comparison values of all alternative are shown in Table 12.

Criteria	$\tilde{r}_i$		
Regulation for health insurance	1.97	2.38	2.77
Open job openings for crushing operators from affected environments	1.09	1.19	1.30
Hold open communication with the environment regularly	1.86	2.16	2.45
Training workers and making operational standards for processes	0.71	0.83	0.96
Infrared Repair (Machines and Work Environment)	2.01	2.25	2.47
Prioritizing the distribution of CSR funds to the nearest environment	2.09	2.36	2.73
Total	9.73	11.16	12.68
Reverse (power of -1)	0.10	0.09	0.08
Increasing Order	0.08	0.09	0.10

Table 12:- Geometric Means of Fuzzy Comparison Alternative

The relative fuzzy weights of each alternative are given in Table 13;

Criteria	$\widetilde{W}_i$		
Regulation for health insurance	0.16	0.21	0.28
Open job openings for crushing operators from affected environments	0.09	0.11	0.13
Hold open communication with the environment regularly	0.15	0.19	0.25
Training workers and making operational standards for processes	0.06	0.07	0.10
Infrared Repair (Machines and Work Environment)	0.16	0.20	0.25
Prioritizing the distribution of CSR funds to the nearest environment	0.16	0.21	0.28

Table 13:- Relative Fuzzy Weights of Each Alternative

- **Step 6 and Step 7:** Need to de-fuzzified by Centre of an area and Normalized non-fuzzy number

In the sixth step, the relative non-fuzzy weight of each alternative (Mi) is calculated by taking theaverage of fuzzy numbers for each alternative. In the seventh step, by using non-fuzzy Mi's, the normalized weights of each alternative are calculated and tabulated in Table 14.

Criteria	Mi	Ni
Regulation for health insurance	0.218	0.213
Open job openings for crushing operators from affected environments	0.108	0.106
Hold open communication with the environment regularly	0.197	0.193
Training workers and making operational standards for processes	0.076	0.075
Infrared Repair (Machines and Work Environment)	0.205	0.200
Prioritizing the distribution of CSR funds to the nearest environment	0.219	0.214

Table 14:- Averaged and Normalized Relative Weights of Alternative

Depending on these results, the main priority variable is the creation of environmental security and prioritizing the distribution of CSR funds to the nearest environment as the first alternative that must be done immediately.

V. CONCLUSION

By employing a systems-based methodology such as SSM we have been able to see the perceptions solution analysis of strategy selection to settlement conflicting interests caused by noise intensity in the workplacefrom the community, local government, and company. Therefore, communication should be established between the two sides in order to obtain a balance to be immediately realized an alternative action plan. In this study, the Analytical Hierarchy Process technique is used empowered with a fuzzy approach. Since the decision makers preferences depend on both tangible and intangible criteria, these vague linguistic variables should be represented by Fuzzy Set Theory. Hence Fuzzy AHP model is utilized to solve the main selection problem of purpose criteria and alternative, which should determine the immediate action plan among 6 (six) alternatives. As a result of the case study, the main priority variable is the creation of environmental security and prioritizing the distribution of CSR funds to the nearest environment as the first alternative that must be done immediately. In further studies, as stated before, other models such as Fuzzy ANP or ELECTRE can be applied to the same problem and the results can be compared. In addition, hybrid models combining different methodologies incorporating the strong sides of each can be performed to solve this problem.

REFERENCES

[1]. Ayhan, M. B. (2013). A fuzzy AHP approach for supplier selection problem: A case study in a Gear motor company. *arXiv preprint arXiv:1311.2886*.

[2]. Bayer, R., & Karamaşa, Ç. (2018). Analyzing Destination Attributes Under Fuzzy Environment: A Case Study in Eskişehir. *European Journal of Tourism Research*, *18*, 75-94.

[3]. Bernardo, H., Gaspar, A., & Henggeler Antunes, C. (2018). A Combined Value Focused Thinking-Soft Systems Methodology Approach to Structure Decision Support for Energy Performance Assessment of School Buildings. *Sustainability*, *10*(7), 2295.

[4]. Booton, C. M. (2018). Using Rich Pictures to Verify, Contradict, or Enhance Verbal Data. *The Qualitative Report*, *23*(11), 2835-2849.

[5]. Buckley, J. J. (1985). Fuzzy hierarchical analysis. *Fuzzy sets and systems*, *17*(3), 233-247.

[6]. Chang, D. Y. (1996). Applications of the extent analysis method on fuzzy AHP. *European journal of operational research*, *95*(3), 649-655.

[7]. Checkland, P. B. (1981). *Systems thinking systems practice.* Chichester: John Wiley and Sons.

[8]. Checkland, P. (2000). Soft systems methodology: a thirty year retrospective. *Systems research and behavioral science*, *17*(S1), S11-S58.

[9]. Checkland, P., Scholes, J., & Checkland, P. (1990). *Soft systems methodology in action* (Vol. 7). Chichester: Wiley.

[10]. Checkland, P., & Poulter, J. (2006). *Learning for action: a short definitive account of soft systems methodology and its use, for practitioners, teachers and students*. John Wiley and Sons Ltd..

[11]. Chen, Z., Chen, T., Qu, Z., Yang, Z., Ji, X., Zhou, Y., & Zhang, H. (2018). Use of evidential reasoning and AHP to assess regional industrial safety. *PLoS one*, *13*(5), e0197125.

[12]. Flood, R. L. (2000). A brief review of Peter B. Checkland's contribution to systemic thinking. *Systemic Practice and Action Research*, *13*(6), 723-731.

[13]. Hsu, C. W., Kuo, R. J., & Chiou, C. Y. (2014). A multi-criteria decision-making approach for evaluating carbon performance of suppliers in the electronics industry. *International Journal of Environmental Science and Technology*, *11*(3), 775-784.

[14]. Jackson, M. C. (2003). *Systems thinking: Creative holism for managers* (p. 378). Chichester: Wiley.

[15]. JIS Z 8106 [IEC60050-801] International electro-technical vocabulary Chapter 801: Acoustic and electroacoustic

[16]. Kearney, G. D., Balanay, J. A. G., & Mannarino, A. J. (2017). Effectiveness of a Multifaceted Occupational Noise and Hearing Loss Intervention Among Landscaping and Groundskeeping Workers. *Journal of Environmental Health*, *80*(3), 8-16.

[17]. Kordi, M. (2008). Comparison of fuzzy and crisp analytic hierarchy process (AHP) methods for spatial multicriteria decision analysis in GIS.

[18]. Ma, L., Shen, S., Zhang, J., Huang, Y., & Shi, F. (2010). Application of fuzzy analytic hierarchy process model on determination of optimized pile-type. *Frontiers of Architecture and Civil Engineering in China*, *4*(2), 252-257.

[19]. Maqsood, T., Finegan, A. D., & Walker, D. H. (2001). Five case studies applying soft systems methodology to knowledge management.

[20]. Noh, J., & Lee, K. M. (2003). Application of multiattribute decision-making methods for the determination of relative significance factor of impact categories. *Environmental Management*, *31*(5), 0633-0641.

[21]. Novani, S., Putro, U. S., & Hermawan, P. (2014). An application of soft system methodology in batik industrial cluster solo by using service system science perspective. *Procedia-Social and Behavioral Sciences*, *115*, 324-331.

[22]. Patil, A. N. (2018). Fuzzy ahp methodology and its sole applications.*International Journal of Management Research and Reviews*, *8*(5), 24-32.

[23]. Safari, H., Soufi, M., & Aghasi, E. (2014). Select a Hypermarket Location Based on Fuzzy Multi Criteria Decision Making (F-MCDM) Techniques (Hybrid of F-Delphi, F-AHP, F-LLSM and F-PROMTHEE). *Kuwait Chapter of Arabian Journal of Business and Management Review*, *33*(2579), 1-20.
[24]. Salomons, E. M., & Janssen, S. A. (2011). Practical ranges of loudness levels of various types of environmental noise, including traffic noise, aircraft noise, and industrial noise. *International journal of environmental research and public health*, *8*(6), 1847-1864.
[25]. Smith, A. (2003). The concept of noise sensitivity: Implications for noise control. *Noise and Health*, *5*(18), 57.
[26]. Sunal, A. B., Sunal, O., & Yasin, F. (2011). A comparison of workers employed in hazardous jobs in terms of job satisfaction, perceived job risk and stress: Turkish jean sandblasting workers, dock workers, factory workers and miners. *Social Indicators Research*, *102*(2), 265-273.
[27]. van de Water, H., Schinkel, M., & Rozier, R. (2007). Fields of application of SSM: a categorization of publications. *Journal of the Operational Research Society*, *58*(3), 271-287.
[28]. Warwick, J. (2008). A case study using soft systems methodology in the evolution of a mathematics module. *The Mathematics Enthusiast*, *5*(2), 269-290.
[29]. Yu, Q., & Hou, F. (2016). An approach for green supplier selection in the automobile manufacturing industry. *Kybernetes*, *45*(4), 571-588.