Available Online : https://proceeding.researchsynergypress.com/index.php/cset/index
RSF Conference Series: Engineering and Technology
ISSN 2809-6843 (Online) | 2809-6878 (Print)
Volume 2 Number 2 (2022): 37-48

Determining the Priority Element in Safety Management System of Public Transport with Analytic Hierarchy Process (AHP)

Destria Rahmita[1], Edi Purwanto[2], Ethys Pranoto[1], Pipit Rusmandani[1]
[1] Polytechnic of Road Transportation Safety, Jalan Semeru No. 3 Tegal, Indonesia
[2] PTDI-STTD, Bekasi, Indonesia

Abstract

Safety Management of Public Transport Company (SMK-PAU) has become mandatory for all transportation service providers. SMK-PAU has ten elements of management systems. This present study aims to illustrate how the ten elements are employed. Analytic Hierarchy Process (AHP) was used to determine which of the ten elements is a priority in the Safety Management of Transportation Company in accordance with Transportation Ministerial Regulation No 85 of 2018 concerning the Safety Management of Public Transport Company based on the respondent group. The respondents were academics, regulators, and operators of public transport. The finding revealed that the precedence element was the element of hazard and risk management as well as the enhancement of competency and training.

Keywords: *Safety Management System, Public Transport Company, AHP*

INTRODUCTION

Transportation companies as service providers of goods and people transport (commercial vehicles) should prioritize safety by minimizing the risk of traffic accidents. Although the percentage of a traffic accidents involving public transportation is relatively small, its fatality is still elevated. Each year, the escalation of traffic accidents taking in two types of vehicles, both people and freight vehicles, is taken place. Elicited from the data in 2018, truck collisions were in the top three; the rank indicates that there was a shortage in quantity as well as quality, as quoted from Mr. Budi Setiyadi, General Director of Road Transportation Agency, in the webinar on April 20th, 2021, entitled Government and Operator Synergy in Manifesting Safe Transport. According to Yati (2021a), traffic accident entangling commercial vehicles will potentially lead to many victims even if it does not occur very often as in motorcycle collisions.

To recall what had happened in the past three years, traffic collisions encompassing public transportation predominated the news. It was reported that eight people died and a dozen were injured because of a single bus accident after visiting Tangkuban Perahu (Kompas.com, 2020). The bus was transporting 58 passengers from Depok when suddenly it collapsed after passing a way down (Nagrek downhill—as people refer to) in Ciater District, Subang regency (Permadi, 2020). Another accident was AKAP (inter-cities and inter-provinces) bus. An AKAP bus with 50 passengers was heading from Bengkulu to Palembang when it collided in the city of Pagaralam on Monday, December 23rd, 2019. It caused 24 people dead, and 13 were injured. The bus fell into a bottom of a ravine (150m depth) in the 9th km of Jalan Lintas Pagar Alam-Lahat, The Village of Plang, Plang Kenidai District, Dempo Tengah Kota Pagar Alam Subdistrict (Rachmawati, 2019).

Corresponding author
Destria Rahmita, destria@pktj.ac.id
DOI: 10.31098/cset.v2i2.557

Similar to the bus (people-transporting vehicle), collisions often occur in the truck (goods-transporting vehicle). In 2018, a dramatic accident caused four people dead, and 11 people got injured on Monday, December 10th. It was in the Kretek flyover, in Bumiayu Subdistrict, Brebes Regency, Central Java. As reported by Liputan6.com, there was a speeding-dense-mass-freight vehicle going the way down. It hit four cars and ten other vehicles ahead (Flora, 2018).

When we look closely to the accidents, there is a high level of fatality in an accident involving commercial vehicles, both transporting goods and people. It is an alarming situation that indicates the lack of safety in the public vehicle of transport service. Therefore, the actions and recommendations to improve the safety management of public transport companies are critical.

As human life evolves, human mobility and goods will also develop. Even during COVID-19, when human mobility is restricted, the mobility of goods increases. The alteration may raise innovations and new management systems. Therefore, factors causing collision cannot be determined only from findings in the location of an accident but also from other factors that should be comprehensively and holistically taken into account. National Transportation Safety Committee (KNKT) normally investigates several factors which are potential as collision triggers. The investigation reports are generally categorized into:

1. Human factor, human as the road users is the main factor of traffic movement.
2. Means, the main tools to transport goods and people is vehicle.
3. Infrastructure, the factors that support road transportation
4. Environmental factor, it is essential as the transportation process of goods and people occurs in.
5. Specific causative factor, inappropriate regulation, and policies (Saputra, 2017)

The government clearly states that the transport company must employ the Safety Management System of Public Transport Company. It is expected that by strictly enforcing SMK-PAU, the number of traffic accidents involving public transport and its fatality decreases. Safety Management of Public Transport Company, based on Ministerial Regulation No 85 of 2018, is defined as a part of public transport company management in terms of safety procedures which are coordinated and holistically carried out as the way to realize the safety of transport and collision-risk management.

Initially, the company may arrange their safety management and practice them. When everything is set, the public transport company can propose a validation from the government in terms of an assessment of their performance regarding safety management. The assessment is based on the ten elements of safety management of public transport. The assessment system of SMK-PAU derived from Perdirjengubdat No. KP.1990/AJ.503/DRJD/2019 focusing on the assessment procedure of SMK-PAU. There are ten elements with the same weight (Dirjendhubdat, 2019). The same Weighting of each element can be biased, yet it is essential to find out which of the elements affects the most. Thus, the goal of SMK-PAU, which is manifesting safety and managing accident risk, can be achieved. The objective of this present study is to illustrate the priority in employing the elements of the safety system of a public transport company.

LITERATURE REVIEW

A. Safety Management System of Public Transport Company

Safety Management System of Public Transport Company refers to a holistic and structured system governing public transportation safety in one integrated-management system. It covers planning, implementing, measuring, and monitoring processes to build safety in public transport (The Indonesian Transportation Minister, 2018)

In addition, the Safety Management System of Public Transport Company is systematically designed with PDCA (Plan-Do-Check-Action) consisting of 10 basic elements. The ten elements are accommodated with desired expectation/goals in line with the needs of each transport company, as illustrated in Figure 1. The ten elements are as follows:

1. Commitment and policies,
2. Organizing,
3. Hazard and risk management,
4. The facility of motorized vehicle repairment and maintenance,
5. Data and documentation,
6. Intensification of training and competency,
7. Being responsive to an emergency,
8. Internal collision reporting,
9. Monitoring and evaluating, dan
10. Assessment on work performance.

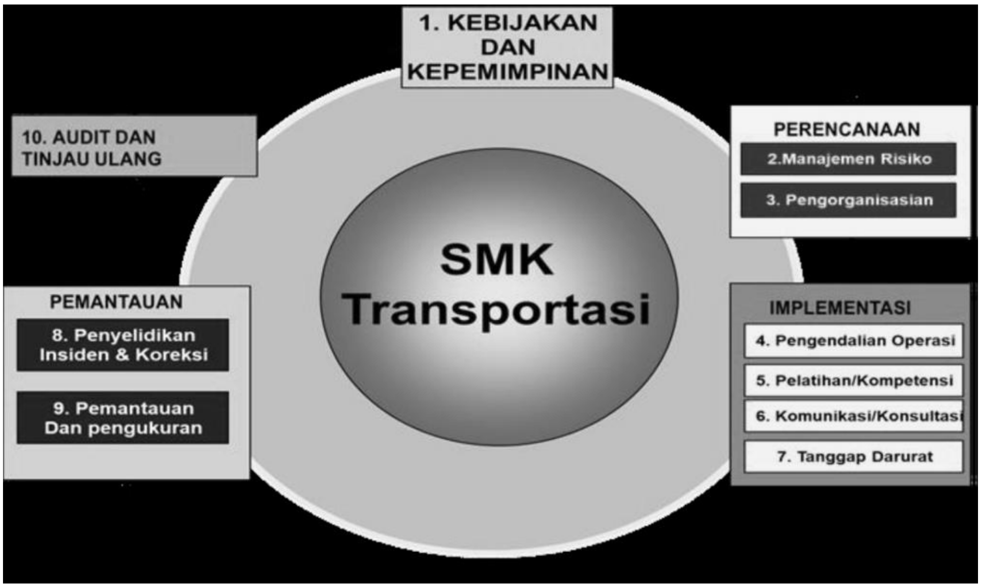

Figure 1. The Structure of Safety Management System

(The Indonesian Minister of Public Transportation 2018)

The public transport company is required to compose, implement, and improve its safety management attributed to the Public National Plan of Safety of Traffic and Road Transport (RUNK LLAJ). The safety management system (SMK-PAU) should be designed for the latest three months after the organization license is issued. The licensee of public transport operation should validate the draft of SMK-PAU in accordance with their authority. Some parties responsible for monitoring and assessing public transport company safety management are the central and local governments. The process includes conditioning with technical guidance and assistance as well as monitoring the implementation of safety management of public transport companies (The Indonesian Transportation Minister, 2018).

B. Analytic Hierarchy Process (AHP)

Analytic Hierarchy Process, commonly called AHP, is a general theory of measurement in determining the scale of ratio, both criterion ratio and alternative ratio, which are mutual. The ratio can be seen from the true measurement or basic scale showing the ability to sense and tendency. AHP specifically focuses on the deviation of determination and judgement and the attachment within and between constituent structural elements. AHP is mainly implemented in the decision-making process that involves multiple planning criteria, estimation, determination of human resources, and matrix creation.

There are several studies employing AHP to solve problems in transportation. The first study was from Tunisia. When Tunisia was facing a pitfall in social and economy in which there was a significant decrease in income and a significant increase in expense, the Tunisian government sought for solution dealing with transportation. The study's finding showed a practical solution; it was by developing evaluation criteria that could define the well-performed public transport vehicle operators. Later, the criteria became standard for other operators with different types of transport vehicles (Boujelbene & Derbel, 2015).

Another study was on the hierarchy of decision model to assess the priority element of OHAS 18001 objective with AHP and to select on KPI set to measure the safety performance. The result of the study indicated that the proposed method had become an efficient tool to and flexibly diagnose the organization's performance with a quality management system, work environment, and occupational health and safety. It aimed to improve the performance of internal productive processes or administrative support (De Felice et al., 2016).

The AHP method was used to rule the prioritized process blueprint of Guideline BS8800 of the Occupational Health and Safety Management System (SMK3) for the construction industry. The construction industry is categorized into several companies, such as Joint Venture (JV), Extended Warranty (EW), and Small and Medium-Sized Enterprises (SME). The result showed that JV and EW companies had a stronger commitment to strategical Occupational Health and Safety Management System, while SMEs, in the short term, focused on implementing safety management. Further results revealed that safety became the shared issue of the three types of companies. In addition, the ranking system from the study was applicable to be standard of practice in Occupational Health and Safety Management System (SMK3) in other construction companies in Hongkong (Chan et al., 2004).

Four principles to solve problems dealing with AHP are Derivation, Comparative Judgement, Synthesis priority, and Logical consistency (Saaty, 1987). The derivation is a process of breaking down a system problem into its small components or its constituent element. Whereas comparative judgment is the process of measuring the relative needs of two elements at the same level of relation to a higher level. The measurement made is the basis of the AHP method since the process in this stage may affect the prioritized elements that are being compared. Each pairwise comparison matrix is actuated by its eigenvector. Thus, the local priority of each compared-pairwise element will be found out. Now that the number of pairwise comparison matrix in each level depends on the number of compared-alternative elements, synthesis priority should be carried out among local priority to ascertain the global priority. The last stage of AHP is measuring the consistency value with Consistency Index (CI). The tendency weight measurement of pairwise comparison based on nine levels of importance is shown in the following Table 1.

Table 1. Importance Weighting (Saaty, 1987)

Criteria to	Description
1	The two alternatives are important
2	Very slightly more important
3	Relative slightly more important
4	Somewhat more important
5	More important
6	Almost much more important
7	Very-more-important
8	Almost absolute more important
9	Absolute more important

The objective of the present study is to determine the priority in implementing a safety management system of public transportation following the Transportation Ministerial Regulation No 85 of 2018 concerning the Safety Management System of Public Transport Company with an Analytic Hierarchy Process (AHP).

RESEARCH METHOD

As alluded to in the previous discussion, to actuate the priority scale of the implementation of safety management of public transport, Analytic Hierarchy Process (AHP) was employed. Entrenched from the concept and element of BS4500-0:2018 of Occupational Health and Safety Management System, there were five criteria in the study: cost implication, development time, required expertise, client requirement, and corporate image. The five criteria were used to determine the relative importance rank that public transport companies might later use regarding the ten elements of safety management. It was to create safety management of public transport with the AHP method. Figure 2 shows the structure of the three-level AHP adopted in this study.

A. Respondent

The study respondents were categorized into three: public transport operators, such as public transport companies; public transport regulators, such as the licensee of operation management; General Directorate of Transportation Minister and academics which contains the scholar and experts of safety transportation. The selected public transport companies were companies with certified safety management (SMK PAU). Likewise, the chosen regulators were the officials and accessors in charge of issuing SMK PAU certificates. Finally, academics were the lecturers in the field of safety transportation.

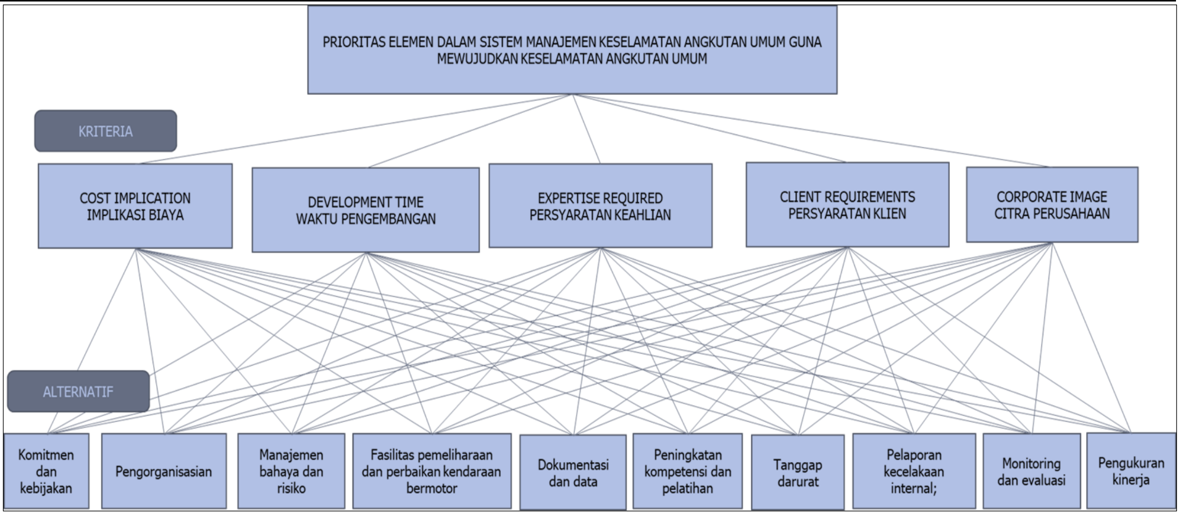

Figure 2. AHP Structure of Priority of Safety Management System of Public Transport

B. Data Collection Instrument

The survey was carried out to respondents with questionnaires in the google form. It was to find out the ratio of pairwise comparison among the criteria and elements in the three being-investigated categories of respondents. AHP enables any number but infinity to be the limit. However, because of the complicated process of determining the ratio of pairwise comparison, it was possible to do a re-survey when there was tangible inconsistency.

The data of pairwise comparison from the survey were tabulated for the following analysis of discovering AHP value. The tabulation process was done for each pairwise comparison, and later, a matrix was created. This study demonstrated the implementation of AHP to select priority elements of safety management and to determine the most affecting criteria for safety performance.

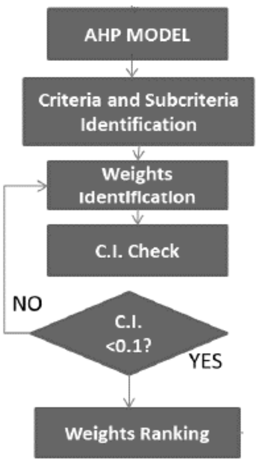

Figure 3. Stages in AHP (De Felice et al., 2016)

C. Data Analysis Technique

There were various stages in AHP which were accomplished in the study, as seen in Figure 3. They are described as follows (Saaty, 1987):

1. First was defining the problem to investigate. It was to state the assumption and presupposition reflected in the problem definition. However, the definition was revised if it did not meet the feasibility. The next step was identifying the impacted parties and investigating how they defined the problem. At last, it was essential to consider how impacted parties participated in AHP.
2. The second stage was arranging the hierarchy from the top from the ultimate goal to factors or criteria from the middle to lowest level (normally, it was being-considered-alternative) and checking whether the level was internally consistent and complete and the relation among levels was clear.
3. The next step was to create a pairwise comparison matrix covering the elements of the set at the above level. In the simple hierarchy, every element at a lower level influenced each element at a higher level. Nevertheless, the lower-level element in another hierarchy only impacted a higher element that needed unique matrix construction.
4. The fourth step was to set the scoring procedure to fill the matrix. It required $(n-1)/2$ score per nxn matrix. The analysts or participating group assessed whether an element dominated B element—if so, put the appropriate integers into the cells in row A, column B and vice versa. Reciprocal was automatically inputted in the counterpart cell.
5. The next was to compute the consistency ratio for each of the matrix. If it was unsatisfactory, re-evaluating was necessary. Stage 3 to stage 5 were redone for all levels of the hierarchy.

$$Consistency\ Index = \frac{\lambda_{max} - n}{n-1}$$

   In which λ_{max} the sum of the normalized priority multiplication and the number of columns of the corresponding matrix.

$$Consistency\ Rasio = \frac{Consistency\ Index}{Random\ Consistency\ Number\ for\ n}$$

   The value of consistency can be found from AHP table for n different value.

6. The final stage was to analyze the matrix to set local and global priorities. It was to check the hierarchy consistency by multiplying each consistency index by prioritizing the appropriate criteria and adding them. Later, the consistency ratio was calculated. If it was far too high, re-evaluating could be done (repeat the question or category). As a general guideline, AHP calculation and analysis were continued if the consistency ratio was less than 0.1. However, if it was more than 0.1, it was suggested that AHP could be redone until it met the consistency value.

FINDINGS AND DISCUSSION

A. Criteria

The respondents' assessments of the criteria of the pairwise comparison showed varied data. The pairwise comparison ratio was values related in the AHP matrix tabulation. The calculation of the criteria for the three categories of respondents is shown in Figure 4.

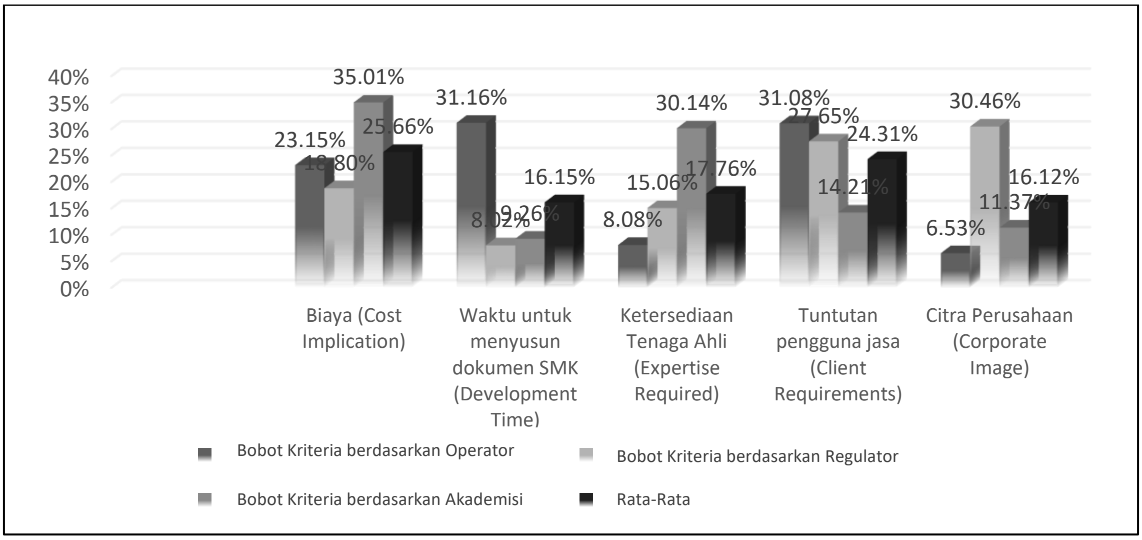

Figure 4. Criteria Priority

The computation of AHP, as in Figure 4, delineates that each group of respondents placed different criteria as the main priority. Operator group considered *client requirements* as the main priority. On the contrary, the regulator group prioritized the *corporate image*. Meanwhile, *cost implication* was considered the preeminent priority by the academic group. Nonetheless, the regulator and academic groups had one thing in common: *development time* was considered the trivial priority when composing a document. The operator group placed *development time* as the second criterion and *corporate image* as the last priority.

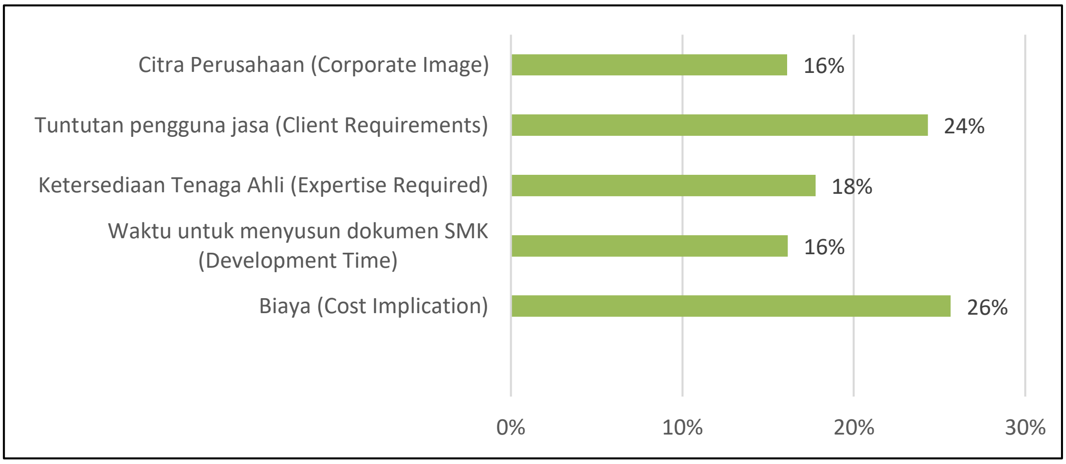

Figure 5. The Priority of Criteria Selection

After the AHP analysis of the three categories of respondents was unified, there was a new priority value, as shown in Figure 5. Criteria priority from the three categories of respondents considered *cost implication* in the first position, while *corporate image* and *development time* was at the last position in the same percentage.

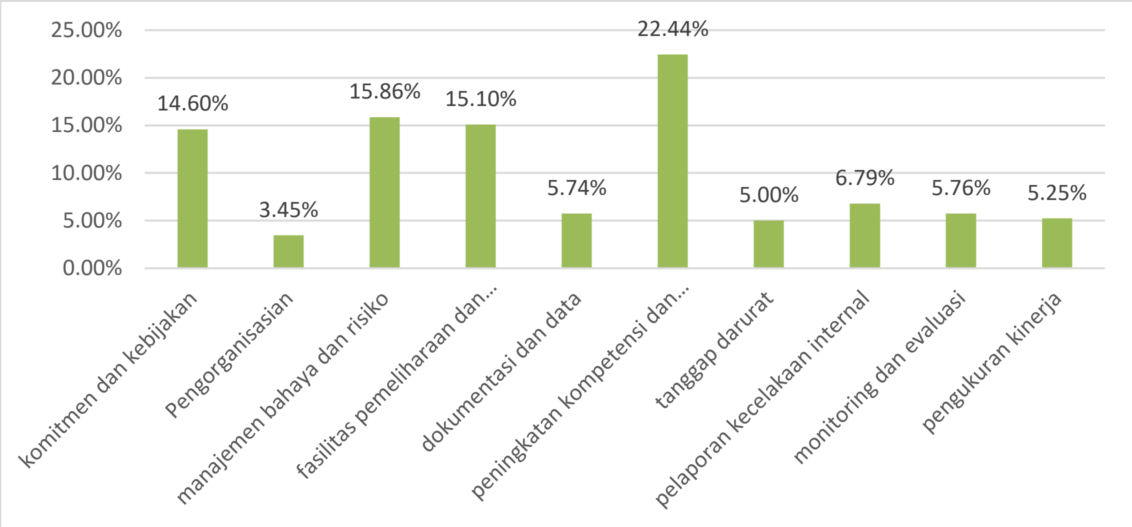

Figure 6. Alternative weighting based on the operator

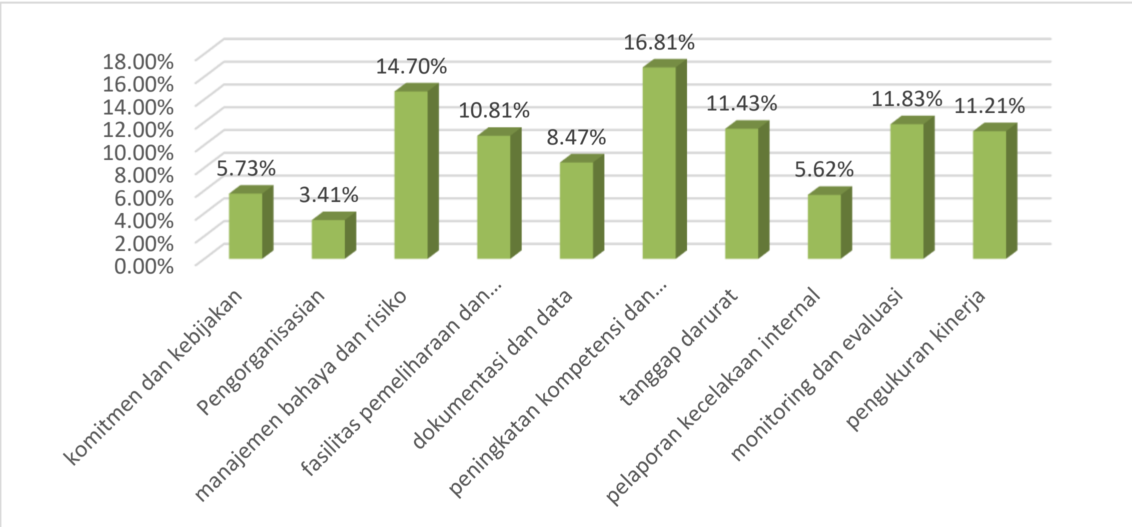

Figure 7. Alternative Weighting Based on Regulator

B. The Element of Safety Management of Public Transport (SMK-PAU)

The calculation of AHP pairwise alternative elements showed diverse results, as in Figure 6 (alternative weight based on the operator), Figure 7 (alternative weight based on regulator), and Figure 8 (alternative weight based on academics). The analysis result of AHP on the alternative element of SMK-PAU showed the common result from the operator and regulator. Both groups *enhanced training and competency* as the priority, while academics put it as the second priority. Academics placed *hazard and risk management* as the priority, yet it was the second priority for the other respondents. *Organizing elements* were put in the last priority by the operator and regulator, but the academics considered *internal collision* reporting in the last priority.

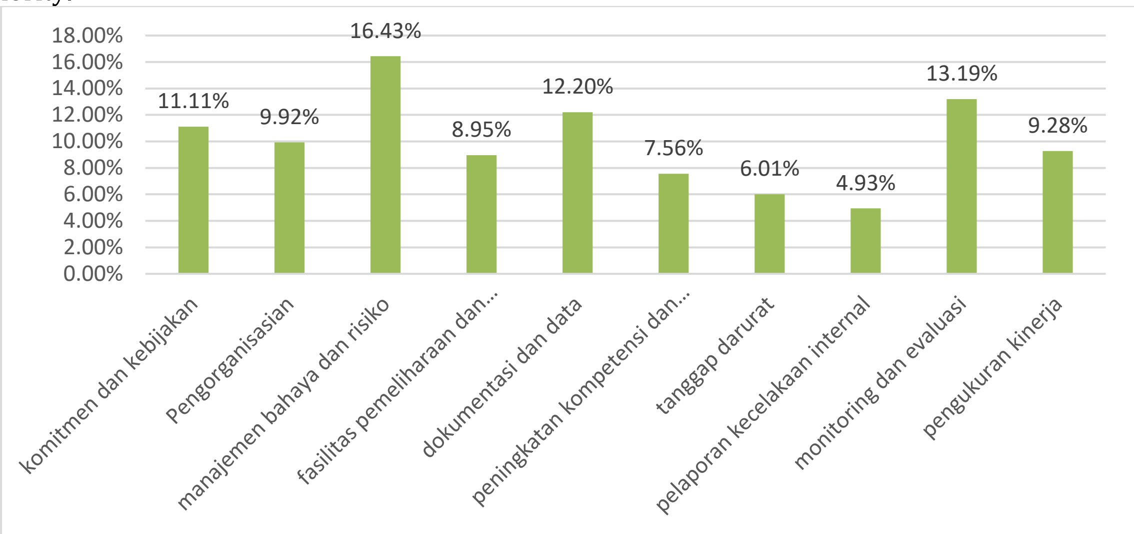

Figure 8. Alternative Weighting based on Academics

The combination of AHP from the three respondents placed two alternative elements of SMK-PAU (*hazard and risk management and the enhancement of competency and training*) as the top priority. However, the alternative element of *organizing and internal collision report* was the final priority.

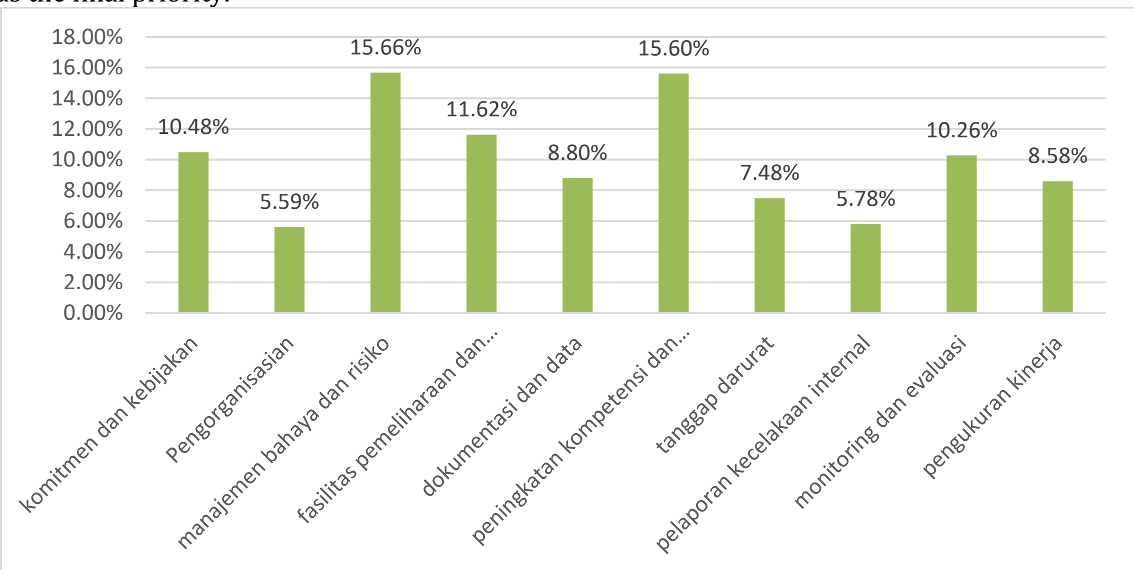

Figure 9. Alternative Selection Priority of the Three Respondents

Hazard and risk management were seen as a process to identify, measure, and ensure the risk. Furthermore, developing a strategy to manage hazards and risk was useful—which is also the first step in the PDCA cycle. This element in the previous priority showed that although SMK PAU has been mandatory since 2018, it still lacks implementation. According to recent data from the transportation minister, from thousands of public transport companies, only 24 own SMK-PAU certifications (Yati, 2021b).

The improvement of competency and training is favourable to emend and enhance attitudes, behaviour, and knowledge of the employees in line with the company's needs to achieve the company's goal. If this element has become the top priority indicates that there was still a lack of understanding of SMK-PAU. Therefore, it is necessary to increase an understanding of SMK-PAU. As a result, there will be more experts in SMK-PAU. Unfortunately, there were only dozens among thousands of public transport operators who got SMK-PAU certification.

CONCLUSION AND FURTHER RESEARCH

A. Conclusion

From the finding and discussion, we may conclude that the operators made *client requirements* as the priority and *development time* as the second priority. In contrast to operators, the corporate image was the main priority and *client requirement* as the second priority for regulators. Meanwhile, academics placed the *cost implication* as the top priority and *expertise required* as the second. However, from the three respondents, it was clear that *cost implication* became the priority of the five selected elements, and the second was *client requirement*.

The cost is essential in managing the company to manifest public transport safety. In addition, safety is the first factor that influences service users to select what public transport they will use to transport.

The three respondents agreed that selecting priority elements in SMK PAU as the alternative to manifest public transport safety enhanced competency and training and hazard and risk management.

Cost implication was beneficial to develop the competency and training from the management, the mechanic, and the driver. It was to bring out public transport safety and hazard and risk management. However, client requirement was essential for fulfilling each element of SMK PAU to be sustainable action.

B. Suggestion

Further research and discussion need to be done to review the Weighting of the ten elements of SMK-PAU in the assessment of SMK-PAU certification, as it is crucial to ensure that each element has the same weight.

REFERENCES

Boujelbene, Younes, & Derbel, A. (2015). The Performance Analysis of Public Transport Operators in Tunisia Using AHP Method. *Procedia Computer Science, 73* (Awict), 498–508. https://doi.org/10.1016/j.procs.2015.12.039.

Chan, A. H.S., Kwok, W.Y., & Duffy, V. G. (2004). Using AHP for Determining Priority in a Safety Management System. *Industrial Management and Data Systems, 104* (5), 430–45. https://doi.org/10.1108/02635570410537516.

Dirjendhubdat. (2019). *Peraturan Direktur Jenderal Perhubungan Darat No. KP.1990/AJ.503/DRJD/2019 Tentang Tata Cara Penilaian Sistem Manajemen Keselamatan Angkutan Umum*.

Felice, F. D., Antonella, P., Balduino, D. S., & Federico Z. (2016). Prioritising the Safety Management Elements through AHP Model and Key Performance Indicators. *15th International Conference on Modeling and Applied Simulation, MAS 2016*, 49–56.

Flora, M. (2018). *5 Fakta Kecelakaan Maut di Bumiayu.* Liputan6.Com. https://www.liputan6.com/news/read/3804397/5-fakta-kecelakaan-maut-di-bumiayu

Menteri Perhubungan Republik Indonesia. (2018). *Peraturan Menteri Perhubungan Republik Indonesia Nomor PM 85 Tahun 2018 Tentang Sistem Manajemen Keselamatan Perusahaan Angkutan Umum*. *Menteri Perhubungan Republik Indonesia*.

Permadi, A. (2020). *Kecelakaan Bus Pariwisata Tewaskan 8 Orang, Korban Selamat_ Sopir Sempat Ketok-Ketok Ban*. Kompas.Com.https://regional.kompas.com/read/2020/01/19/11300021/kecelakaan-bus-pariwisata-tewaskan-8-orang-korban-selamat--sopir-sempat-ketok-ketok-ban

Rachmawati. (2019). *Kecelakaan Bus Sriwijaya 24 Korban Meninggal, Tabrak Pembatas Dan Masuk Jurang 150 Meter*. Kompas.Com. https://regional.kompas.com/read/2019/12/24/11540261/kecelakaan-bus-sriwijaya-24-korban-meninggal-tabrak-pembatas-dan-masuk.

Saaty, R. W. (1987). The Analytic Hierarchy Process-What It Is and How It Is Used. *Mathematical Modelling, 9* (3–5), 161–176. https://doi.org/10.1016/0270-0255(87)90473-8.

Saputra, A. D. (2017). Studi Tingkat Kecelakaan Lalu Lintas Jalan Di Indonesia Berdasarkan Data KNKT (Komite Nasional Keselamatan Transportasi) Dari Tahun 2007-2016. *Warta Penelitian Perhubungan, 29* (1), 179--190. https://doi.org/10.1016/j.injury.2011.11.002.

Yati, R. (2021a). *Kemenhub: Bus Dan Truk Paling Sering Kecelakaan Lalu Lintas.* Bisnis.Com.

Yati, R. (2021b). Miris! Dari Ribuan Operator Angkutan Barang, Cuma 24 Yang Punya SMK. Bisnis.Com. https://ekonomi.bisnis.com/read/20210923/98/1445944/miris-dari-ribuan-operator-angkutan-barang-cuma-24-yang-punya-smk.