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# SAFETY RISK MANAGEMENT BOW-TIE ANALYSIS AND SAFETY PROMOTION IN THE OPERATIONS OF SMALL UNMANNED AIRCRAFT SYSTEMS

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**ABSTRACT**

SUAVs can be post a threat to aircraft because they can cause fatal accidents. Even though its size is much smaller than an airplane, the presence of UAVs in the airport area is strictly prohibited. This study aims to determine the management of risks rising from the operation of SUAVs at Flight Safety Area (*KKOP*) at Soekarno Hatta International Airport. The methodology used is quantitative. Therefore, the authors conclude that risk management is very necessary in the world of aviation, because it concerns mutual safety, and with the increasing number of SUAVs with various types and weights, the authors hope that the level of safety awareness will also be higher for SUAVs users, also called remote pilots.

**Keywords:** *Safety Risk Management, Safety Promotions, Civil Aviation Safety Area, Small Unmanned Aerial Vehicle, Bow-Tie Analysis*

## 1. INTRODUCTION

All aviation stakeholders must work together effectively in order to create aviation safety. This means that every aviation stakeholder has responsibility for and contributes to the creation of aviation safety. Aviation safety is a matter and responsibility of all parties, not only in theory but also in practice through a continuous process of identifying hazards, managing risks, and meeting performance expectations [1]. Modern safety management approaches have developed that lead to safety risks being addressed more proactively by regulators and aviation service providers, instead of relying solely on inspections and actions. Improvements to the final product. A systemic approach to managing safety provides top-level management for handling them effectively so that valuable lessons are applied to improve efficiency and safety [2]. As part of a system, if one institution does not play its role properly, even though other institutions have shown good performance, flight safety will still be difficult to achieve [2]. The same is the case with the handling of the operation of SUAV in the airport area, more specifically in KKOP.

Any safety information system depends crucially on the willing participation of the workforce, the people indirect contact with hazard. In ATM organizations, these are the ATM services personnel undertaking safety-related tasks, such as Air Traffic Controllers, engineering and maintenance personnel, etc. [3]

The use of Small Unmanned Aircraft (SUAV) is growing rapidly in Indonesia. SUAV, or commonly known as drones in the general public, has the meaning of small unmanned aircraft that fly with navigation using a Global Positioning System (*GPS*) tracking system and are controlled using a software system or remote; in short, they are controlled remotely. A drone is also known as an Unmanned Aerial Vehicles (UAV). The author conducts drone certification in 2022. The author also gets information from the news through online media that there are SUAV findings that enter the territory of Soekarno Hatta International Airport.

Airspace in Indonesia is divided into 7 (seven) classifications, namely class A, B, C, D, E, F and G. SUAV in Indonesia operates in class G airspace which is included in uncontrolled airspace. Small unmanned aircraft systems can be pose a threat to aircraft because they can cause fatal accidents. Even though its size is much smaller than an airplane, the presence of SUAV in the airport area is strictly prohibited. As stated in [3]. It is stated that the airspace for the operation of small unmanned aircraft is one of the exceptions, namely in the Flight Operations Safety Area of an airport and Areas within a radius of 3 nautical miles from the coordinate point of the helipad, which is located outside the Flight Operations Safety Area of an airport.

According to PM 14 of 2010 [4] regarding KKOP around Soekarno Hatta International Airport, the KKOP area is determined by a circle with a radius of 15,000 m from the midpoint of each end of the main surface and draws tangents to both circles that are adjacent, and this area does not include the take-off and landing area, the take-off area, and the area under the surface of the cone.

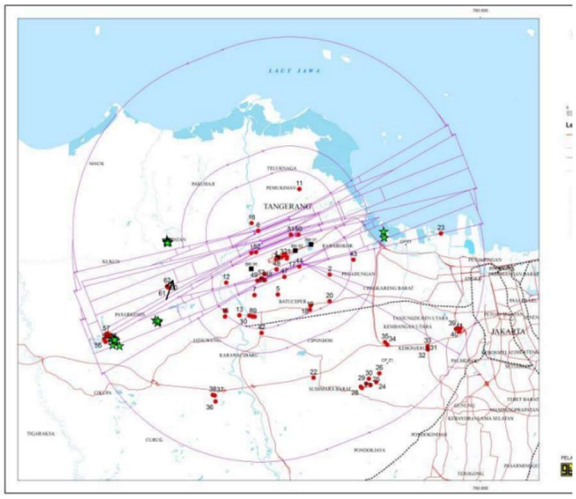


*Figure 1. flight safety area of Soekarno Hatta International airport*
[5]

In Law Number 1 Year 2009 [6] concerning Aviation, Article 210 states that everyone is prohibited from being in certain areas at the airport, creating obstacles, and/or carrying out other activities in the Flight Operations Safety Area (KKOP), which may endanger aviation safety and security unless obtaining permission from the airport authority. Actions that can endanger aviation safety and security can be punished with imprisonment for a maximum of three years and a maximum fine of one billion rupiahs, as explained in Article 421 paragraphs 1 and 2.

Therefore, the authors want to analyze this SUAV based on the 2nd SMS Framework, namely safety risk management, where the risk probability and severity or consequences of the risk are determined in advance, and also on the 4th SMS Framework, namely Safety Promotion. Safety Promotion is a set of tools, processes and procedures used to develop, maintain and improve aviation safety through increasing awareness and changing behavior within an organization [7]. This will be the first study in Indonesia to examine the research into UAVs through the utilization of bow-tie analysis and the methods employed to promote safety. While the primary emphasis is on the second and fourth pillars of the safety management system, the remaining pillars are also deliberated upon as a whole, as they constitute an inseparable entity.

A. Theory Review

1. In Section 2 of the Minister of Transportation Regulation Number 90 of 2015 [8] it is determined that there are 3 zones that must be avoided for the operation of SUAV, namely:
   a. The first zone, prohibited airspace, namely certain airspace over land and/or waters, with permanent and comprehensive restrictions for all aircraft.
   b. The second zone, restricted airspace is airspace over land and/or water with temporary restrictions that can only be used for state flight operations.
   c. The third zone, namely the Flight Operations Safety Area, is the area that covers land, waters and air space and is in the vicinity of the airport.
2. Law number 1 of 2009 [6] section 210

   Everyone is prohibited from being in certain areas at the airport, creating obstacles, and/or carrying out other activities in the Flight Operations Safety Zone (*KKOP*) that could endanger flight safety and security, unless they obtain permission from the airport authority. Actions that can endanger aviation safety and security can be punished with imprisonment for a maximum of 3 (three) years and a maximum fine of one billion rupiah.
3. In the Regulation of the Minister of Transportation of the Republic of Indonesia

Number 63 of 2021 [9] concerning Civil Aviation Safety Regulations Section 107 concerning Small Unmanned Aircraft Systems in article 1 point 2, what is meant by Small Unmanned Aircraft Systems are Small Unmanned Aircraft Systems and related elements, including communication lines and control components of Small Unmanned Aircraft needed for the efficient operation of Small Unmanned Aircraft in the national airspace system.

4. In the document International Civil Aviation Organization Annex 6 Operation of Aircraft [10] Attachment D, point 3.1.2.4, hazards should be identified and safety risks assessed according to predicted probability and the severity of the consequences based on the worst-case foreseeable situation.

   Hazards or hazards must be identified and made into safety risks that are assessed according to the probability and severity of the consequences or consequences based on an estimate of the worst situation that could occur.

5. In the document International Civil Aviation Organization Annex 6 Operation of Aircraft [10] appendix 7-2 concerning Safety Risk Management:

   a. Hazard identification.

      The operator or approved maintenance organization shall develop and maintain a formal process that ensures that hazards in operations are identified. Hazard identification shall be based on a combination of reactive, proactive and predictive methods of safety data collection.

   b. Safety risk assessment and mitigation.

      The operator or approved maintenance organization shall develop and maintain a formal process that ensures analysis, assessment, and control of the safety risks in flight/maintenance operations.

6. The SAG reports to and takes strategic direction from the SRB. It comprises managers, supervisors and staff from operational areas. The Safety Manager may also be included in the SAG. The safety action group:

   a. Oversees operational safety;
   b. Resolves identified risks;
   c. Assesses the impact on safety of operational changes;
   d. Implements corrective action plans; and
   e. Ensures that corrective action is achieved within agreed timescales.

   The safety action group reviews:

   a. The effectiveness of previous safety recommendations; and
   b. Safety promotion [11]

7. Safety Promotion

   Safety promotion means processes and procedures that ensure that aviation personnel are trained and competent to perform their safety management duties, and are prepared for effective two-way communication of safety issues between operational personnel and the organization's management.

   Safety promotion encourages a positive safety culture and helps achieve the service provider's safety objectives through the combination of technical competence that is continually enhanced through training and education, effective communication, and information-sharing. Senior management provides the leadership to promote the safety culture throughout an organization.

   Mandatory compliance with policies and procedures or strict adherence to them cannot be the only means of achieving effective safety management. Safety promotion affects both individual and organizational behavior, and supplements the organization's policies, procedures and processes, providing a value system that supports safety efforts [12].

   ICAO Doc 9859 [13] states that safety promotion plays a supporting yet important role in achieving effective control of safety risks during service delivery. Once employees embrace and understand their responsibilities towards safety performance, it is expected they will actively seek means and information that can be used for effectively accomplishing their responsibilities towards safe aviation." Routine peer-to-peer communication among States and aviation service providers is essential to enhancing the aviation industry's safety culture, increasing awareness of safety issues, and encouraging collaboration that

helps to identify and implement safety enhancement initiatives [12].

Safety promotion is a broad concept based in society. In general there is the same conflict between the concepts of injury prevention and safety promotion as between disease prevention and health promotion [3].

B. Prior Reseach

Based on the Risk Management Analysis of Operation of Unmanned Aircraft (PUTA) with the HIRARC method, using the HIRARC worksheet [14].

Based on analysis of Safety Risk Management at UNNUR Aero Maintenance Training Center (UAMTC), SRM is limited to HIRA (Hazard Identification and risk assessment), using improvement tools such as control charts [7].

Based on Analysis of the effectiveness of the Implementation of safety promotion for workers at PT Lautan Otsuka Chemical in 2012, the effectiveness of the implementation of safety promotion was determined through interviews and observations [15].

## 2. RESEARCH METHOD

A. Place and time

The research was conducted at Soekarno Hatta International Airport [16]. The data processing was carried out at the Indonesia Civil Aviation Polytechnic.

B. Sampling Technique

The population contains objects or subjects with characteristics that also have certain qualities to study and draw conclusions [17]. In this study, the authors determine that population is all personnel who have a Remote Pilot training certificate and are members of the UASTC APDI Jakarta group with a total of 475 members. This APDI group member is a member that contains SUAV users who have done SUAV training. The training here means that you have already conducted training but there is no certainty, that you already have a license or not.

In this study, the authors set a sample of all remote pilots operating SUAV within the UASTC APDI Jakarta group with a total of 95 people using a systematic sampling technique [18]. The sampling technique is a sampling technique [17].

Systematic sampling is an easier procedure than random sampling when you have a large population and the names of the targeted population are available. Systematic sampling involves selecting every nth (i.e., 5th) subject in the population to serve as a sample [19].

C. Data collection

Sugiyono [17] asserts that the caliber of research tools and the caliber of data collection. The quality of research instruments relates to the validity and reliability of the instrument and the quality of data collection regarding the accuracy of the methods used to collect data from documentation study, questionnaire and interview.

A questionnaire is a technique or way of collecting data by giving questions or statements in written form through the Google form media or the like for respondents to answer. The principles of writing a good questionnaire include using language that is adapted to the respondent's language skills. The questionnaire is distributed to members of the APDI Jakarta group, which consists of 475 members; the authors refer to this number as the study population. And the sample is 95 using systematic sampling method. The distribution of the questionnaire was carried out on July 3, 2023 and ended on July 12 2023. The author uses a Likert scale [20] with a scale of 1-5.

The author did this in an unstructured manner to the safety division of the Jakarta Air Traffic Service Center, PUKTA Instructor from BP3 Curug, DJI Consumer & Product Specialist, Lecturer in the Aviation Safety Culture course and former Director of Aviation Navigation, and SUAV users who do not yet have certification.

The initial step of the research was carried out by requesting pilot report data regarding the findings of SUAV at the KKOP of Soekarno Hatta International Airport, namely the period 2018-2023, where the author obtained the data, which contained 7 pilot reports regarding the presence or view of SUAV at the KKOP of Soekarno Hatta International Airport. Then the author also asks for KKOP data for Soekarno Hatta International Airport and data for applicants for the operation of SUAV at KKOP for Soekarno Hatta International Airport.

*Table 1. SUAV Pilot report*

[21]

| No. | DATE/TIME | CLASSIFICATION | AIRCRAFT | DESCRIPTION |
|---|---|---|---|---|
| 1 | 12/31/2018 | Hazard | GIA235 | A chronological re by a DRONE in A UTC ATC Officer. supervisor and to t Manager about the drones in transponder radar at the Point PRIOK 12:46 UTC GIA 3 WARR to WIII po Runway 25L. |
| 2 | 5/04/2019 | Hazard | GIA235 | GIA235 WAHS-W REPORTED DRO ACTIVITY ON (T FINAL RWY 25 L |
| 3 | 6/30/2020 | Hazard | LNI3897 | POSITION 3NM F TOUCH DOWN Z 700 FEET REPOR DRONE ON THE LOCALIZER RW ALREADY INFO MR. SUGAN. |
| 4 | 7/25/2020 | Hazard | LNI697 | When performing runway 07L Pilot s which have been c Drone flying near |
| 5 | 10/17/2020 | Hazard | GIA552 | we saw a drone, cr level. Position fron on Crossing Radial 345)/5.5NM |
| 6 | 11/28/2020 | Serious Incident | BTK6722 | PASSING 3100 FT APPROACHING WINRAR PILOT ALMOST COLLECTING A (UNKNOWN THE OWNER) |
| 7 | 10/31/2021 | Hazard | CTV632 | 08.30 UTC AFTE RWY 07L CTV63 |
| | | | | REPORTED THA WAS A DRONE WITH AN ALTIT APPROXIMATEL |

There were 7 pilot reports in the 2018-2021 period, while in 2022-2023 there were no pilot report findings regarding PUKTA. In 2018 [21], there was 1 report from the Garuda Indonesia 325 aircraft from WARR to WIII with the Hazard category. Then in 2019, there was 1 Garuda Indonesia 235 pilot report from WAHS to WIII on the left of the 25L final runway and it was classified as a hazard. In 2020 there were 4 pilot reports, with 3 including the hazard category and 1 serious incident category.

*Table 2. SUAV operation applicant data* [22]

| No | Applicant | Date | Area |
|---|---|---|---|
| **1** | Angkasa Pura II Soekarno Hatta | February 2022 | TOD until train station |
| **2** | Polresta Soekarno Hatta airport | May 2022 | Polresta airport office |
| **3** | Sintanala Hospital | November 2022 | Sintanala Hospital area |
| **4** | Polresta Soekarno Hatta airport | December 2022 | Polresta airport office |
| **5** | DKI Jakarta provincial goverment | November-December 2022 | Jakarta area |
| **6** | Angkasa Pura II & Pertamina | February 2023 | Terminal 2 |
| **7** | KJSB | February-March 2023 | Tangerang regency |

Data from 2018-2023 [22], there are 7 applicants for the operation of PUKTA at the KKOP of Soekarno Hatta Airport in the 2022-2023 period, while for 2018-2021 there is no data on applications for the operation of PUKTA at the KKOP of Soekarno - Hatta International Airport; 2 of them are applicants from Angkasa Pura II, 2 another from the Airport Police, 1 from the DKI Jakarta Provincial Government, 1 from the Sintalana Hospital, and 1 from the Licensed Surveyor Service Office (KJSB).

The author created and distributed questionnaires to SUAV users who are members of the APDI Jakarta group, where the author is also a member of the APDI Jakarta.

The questionnaire that the author created was distributed based on the Standard Operational Procedure for Safety Risk Assessment of Unmanned Aircraft (PUTA) Airnav Indonesia (SOP.116/S/00/LPPNPI/KMP.05.02/XII/2021) [23]. By distributing the questionnaire, the author hopes to gain knowledge about SUAV operating regulations as well as handling in the event of an emergency when operating SUAV.

Furthermore, the authors conducted structured interviews with 2 validators, namely Ms. Dwi Lestary as a lecturer in the PPI Curug Safety Management System and Mr. Endro as a safety practitioner from JATSC. The purpose of holding interviews is to strengthen the author's research analysis. The following are the sources the author interviewed, Safety Culture Lecturer, UAV lecturer and expert from BP3 Curug, JATSC Safety Division, DJI Product Specialist, Pilot, and unlicensed SUAV user.

D. Data analysis method

In the questionnaire that has been distributed, researchers use a Likert scale with numbers 1-5. The Likert scale is used to assess the views, attitudes, or opinions of a person or group towards an event or social phenomenon, according to the operational

definition set by the researcher. With the following calculations:

*Table 3. Likert scale calculation formula*

[17]

| Calculation formula = T x Pn | |
|---|---|
| **T** | Total respondent |
| **Pn** | Choice of likert score n |

For the analysis, the writer uses Safety Risk Management with a tool called BowTie.

Based on document 9859 SMS Manual 4th edition [13] and SMS Handbook [24] 1st edition 2020, Risk Management process:

1. Hazard identification

   Hazard identification is the first step in the SRM process. Service providers must develop and maintain a formal process to identify hazards that may impact flight safety in all areas of their operations and activities. This includes equipment, facilities and systems. Every hazard related to aviation safety that is identified and controlled is beneficial for the safety of operations.

2. Risk analysis probability

   Once the hazard consequences have been determined, the next step is to assess the probability of the risk. The probability of a safety risk is the likelihood that a safety consequence or outcome will occur.

*Table 4. Risk probability scale*

[24]

| Likelihood | Meaning | Value |
|---|---|---|
| **Frequent** | Likely to occur many times (has occurred frequently) | 5 |
| **Occasional** | Likely to occur sometimes (has occurred infrequently) | 4 |
| **Remote** | Unlikely to occur, but possible (has occured rarely) | 3 |
| **Improbable** | Very unlikely to occur (not known to have occurred) | 2 |
| **Extremely improbable** | Almost inconceivable that the event will occur | 1 |

3. Risk analysis severity

   The severity assessment should consider all possible consequences associated with the hazard, taking into account the worst - foreseeable situation.

*Table 5. Risk severity scale*

[24]

| Severity | Meaning (ICAO SMM) | Value |
|---|---|---|
| **Catastrophic** | • Equipment destroyed<br>• Multiple deaths | A |
| **Hazardous** | • A large reduction in safety margins<br>• Serious injury<br>• Major equipment damage | B |
| **Major** | • A significant reduction in safety margins<br>• Serious incident<br>• Injuries to person | C |
| **Minor** | • Nuisance<br>• Operating limitations<br>• Use of emergency procedures<br>• Minor injuries | D |
| **Negligible** | • Low consequences | E |

4. Risk assessment and tolerability

   After getting the probability and severity level in the previous step, a safety risk will be created, as the table below.

*Table 6. Risk assesment and tolerability scale*

[24]

| Safety Risk | | Severity | | | | |
|---|---|---|---|---|---|---|
| Probability | | Catastrophic A | Hazardous B | Major C | Minor C | Negligible E |
| Frequent | 5 | 5A | 5B | 5C | 5D | 5E |
| Occasional | 4 | 4A | 4B | 4C | 4D | 4E |
| Remote | 3 | 3A | 3B | 3C | 3D | 3E |
| Improbable | 2 | 2A | 2B | 2C | 2D | 2E |
| Extremely Improbable | 1 | 1A | 1B | 1C | 1D | 1E |

5. Risk control/mitigation

   ISO 31010 is an international standard 'risk assessment techniques' that consists of 31 risk assessment techniques, starting with identification, analysis and risk evaluation. ISO 31010 is a supporting document from the main document, namely ISO 31000, in other words,

is an International Standard of Risk Management. The BowTie method is a technique that refers to a diagram in the form of a bow tie that describes or visualizes the risk events faced. Visualization of the bow tie diagram, the left side visualizes proactive risk management, while the right side visualizes protective risk management. The software used to make this BowTie is BowTie XP [25].

The BowTie technique was first introduced by the University of Queensland Australia, and can be used in various fields, such as aviation, finance, mining, and other industries. The Bowtie technique is a marriage between two techniques; the fault tree analysis technique and the event tree analysis technique. Fault tree analysis is on the left, containing the causes of an event. Event tree analysis is on the right side of the top event, the chart on the right is for event recovery/mitigation.

Safety promotion plays a supporting yet important role in achieving effective control of safety risks during service delivery [26]. Safety promotion includes the development of products and actions such as reports and technical publications, bulletins, leaflets and posters; audio-visual material; toolkits, manuals, and guides, social media and e-applications; and also conferences, safety events, roadshows, and campaigns. Safety promotion sets the tone that predisposes both individual and organizational behavior and fills in the blank spaces in the organization's policies, procedures and processes, providing a sense of purpose to safety efforts. Through safety promotion, an organization adopts a culture that goes beyond merely avoiding accidents or reducing the number of incidents, although these are likely to be the most apparent measures of success. It is more to do the right thing at the right time in response to normal and emergency situations.

1. Training and education
   The main purpose of the safety training program is to ensure that personnel, at all levels of the organization, maintain their competence to fulfil their safety roles; therefore, competencies of personnel should be reviewed on a regular basis.
   a. Employees must understand the SMS
   b. Employees benefit from safety lessons learned.
   c. Explain why particular actions are taken.
   d. Develop awareness of hazards.
   e. Foster open reporting of safety concerns.
   f. Initial and ongoing training.

2. Safety communication
   a. The organization shall develop and maintain formal means for safety communication that;
   b. Ensures that all personnel are fully aware of the SMS;
   c. Conveys safety critical information;
   d. Raise awareness of new safety risk controls and corrective actions;
   e. Provide information on new or amended safety procedures;
   f. Promote a positive safety culture and encourage personnel to identify and report hazards;
   g. Provide feedback.

## 3. RESULTS AND DISCUSSION

SUAV Risk Management at KKOP Soekarno Hatta International Airport:

A. Hazard identification

The operation of SUAV took place within the KKOP of Soekarno Hatta International Airport by looking at pilot report data regarding the existence of SUAV from March 2018 to March 2023 at the KKOP of Soekarno Hatta International Airport. There was a SUAV that entered the Soekarno Hatta International Airport (KKOP) due to a lack of understanding of the SUAV regulations that apply in Indonesia. Indeed, the use of SUAV is currently widespread, both for making personal documentation and for making professional films. Due to the lack of understanding of flight regulations, especially the operation of SUAV, a hazard can arise at the KKOP of Soekarno Hatta International Airport.

B. Risk analysis probability
From the pilot report data regarding the operation of SUAV without a permit, this case is classified as remote, it can happen once a year or it can happen in the near future.

C. Risk analysis severity
From the data obtained from the pilot report regarding the operation of an unlicensed SUAV at the KKOP of Soekarno Hatta

International Airport, this case is included in the hazardous, where injury can occur as well as fatal damage.

D. Risk assessment and tolerability

Based on the severity obtained, namely 3B (remote and hazardous), it includes a tolerable index tolerance. The purpose of this index is that it can be accepted by carrying out appropriate and appropriate risk controls.

E. Risk control/mitigation

Furthermore, the safety risk management mitigation process is carried out with a tool called BowTie using an application called BowTie XP. BowTie XP is the most widely used risk assessment software based on the bowtie method, which allows us to easily create bowtie diagrams to assess risks. BowTie XP has the ability to visualize complex risks in an understandable way, but also allows for detailed risk-based improvement plans.

The output of the BowTie Model is a better understanding of incident/accident sequences. From 1 top event regarding the operation of SUAV in KKOP, 7 threats and 6 consequences, 13 prevention barriers, 13 mitigation barriers and 3 escalation factors can be included. The following is an explanation of the BowTie analysis results:

1. Hazard
   SUAV Operation at Airport KKOP.
2. Top event
   Collision between manned aircraft and unmanned aircraft.
3. Threat
   a) Lack of knowledge of SUAV regulations
   b) The community has not been properly socialized regarding the operation of SUAV.
   c) Many are sold freely which are not equipped with a security system / safety warning.
   d) SUAV pilots' awareness of the operating area or flight area.
   e) Incorrect propeller installation (human error).
   f) Does not pay attention to the magnitude of the signal when SUAV takes off (human error).
4. Preventive barriers
   a) Do not fly SUAV at KKOP Airport.
   b) Carry out official permits for the operation of SUAV at the Airport KKOP.
   c) Read and understand PM 37 of 2020.
   d) Read and understand PM 63 of 2021/PKPS 107.
   e) Participate in SUAV-regulation socialization activities.
   f) Following the SUAV certification from the relevant official organization.
   g) It is recommended to buy SUAV that is equipped with a safety warning.
   h) If you have SUAV without a safety warning, then limit yourself to the SUAV operating area.
   i) Understand the SUAV operational area plan.
   j) Read and understand the red zone in the SUAV safety warning.
   k) Re-check takeoff preparation before flying SUAV.
   l) More practice flying SUAV.
   m) Waiting for a GPS signal of at least 9 bars.
5. Consequence
   a) Engine fire.
   b) Winsheeld cracked.
   c) Damage to the fuselage.
   d) The manned plane failed to land.
   e) Losing airlines.
   f) SUAV will fall and cannot be used again if it experiences a total loss.
6. Recovery barriers
   a) Do not fly SUAV at KKOP Airport.
   b) Re-read the applicable SUAV operating regulations.
   c) Avoid operating SUAV in Airport KKOP.
   d) Pay attention to safety warnings and areas where SUAV operations are prohibited.
   e) Increase flight hours in areas that are allowed to fly.

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f) Checking and updating the latest software independently.

7. Escalation factor
   a) Re-read the SUAV guidebook or manual book regarding safety warnings.
   b) Recurrent certification training.
   c) Contact an authorized technician regarding software updates.

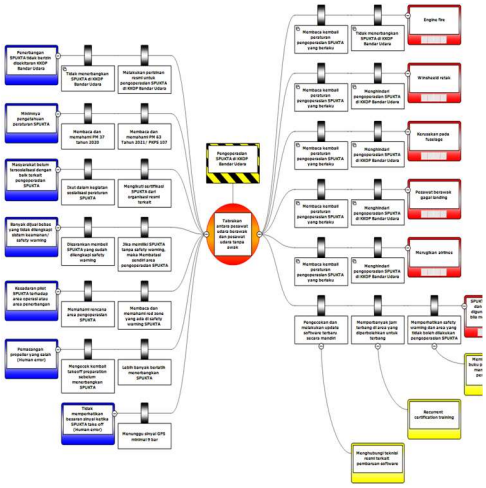

*Figure 2. Bowtie analysis using bowtie XP*
*(Source: result of the author's analysis)*

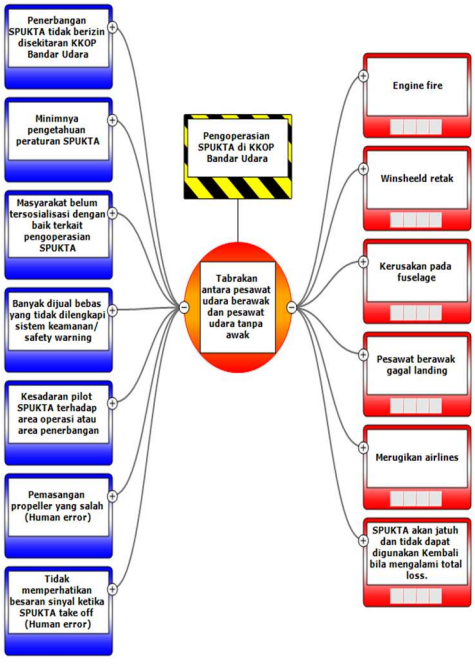


*Figure 3. Bowtie analysis: hazard, top event, consequences*
*(Source: result of the author's analysis)*

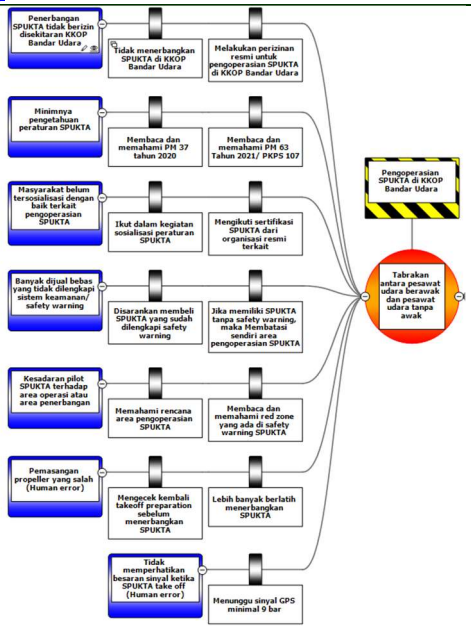


*Figure 4. Bowtie analysis: hazard, top event, consequences, preventio barriers*
*(Source: result of the author's analysis)*

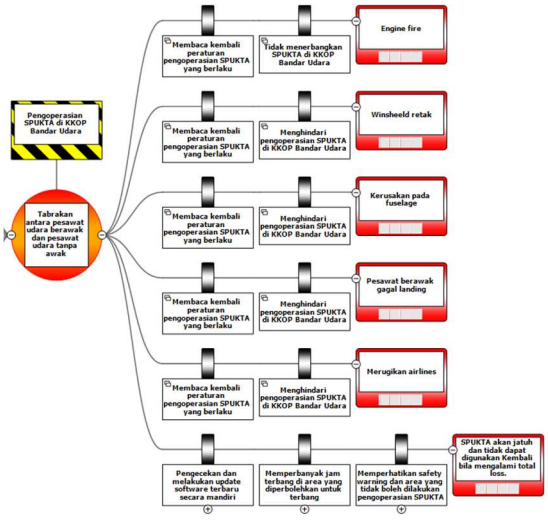


*Figure 5. Bowtie analysis: hazard, top event, consequences, mitigation barriers*
*(Source: result of the author's analysis)*

SUAV safety promotion at KKOP Soekarno Hatta International Airport:

Safety promotion has a supporting role, as well as an important one, in achieving effective safety risk control during service delivery. Safety promotion includes the development of products and measures such as technical reports and publications, bulletins, flyers, posters; audio-visual materials, toolkits, manuals and guides; social media and

electronic applications; as well as conferences, safety events, roadshows, and campaigns.

1. Training and Education

Airnav Indonesia, through the Directorate General of Civil Aviation has 8 lists of affiliated SUAV training centers, namely:

a) UASTC-001/PT. Drone Edutek Indonesia (Drone Edutech)
b) UASTC-002/Indonesian Drone Pilots Association (APDI)
c) UASTC-003/PT. Terra Drone Indonesia
d) UASTC-004/Curug Aviation Education and Training Center (BP3-Curug)
e) UASTC-005/PT. Nusa Technology Circle (Nusadrone)
f) UASTC-006/Indonesia Civil Aviation Polytechnic (PPI-Curug)
g) UASTC-007 / PT. Halo Indah Permai (Halo Robotics)
h) UASTC-008 / Drone Pilot Academy (DPA) (DJPU, 2022).

2. Safety Communications

a) JATSC is a flight operator, so if there are reports of illegal drones at KKOP, JATSC coordinates with the Airport Authority Office Region I.
b) AirNav Indonesia reports aviation safety mitigation to the Coordinating Ministry for Political, Legal, and Security Affairs. AirNav Indonesia reports on mitigation efforts against aviation safety threats to the Coordinating Ministry for Political, Legal and Security Affairs [27]. The Main Director of AirNav Indonesia submitted the report during a working visit to the Assistant Deputy for Coordination of International Law at AirNav Indonesia Jakarta Air Traffic Services Center (JATSC) Branch.

AirNav Indonesia cooperates with stakeholders to work together to ensure flight safety, including the Ministry of Transportation, airport operators, air transport operators, TNI, POLRI, local governments to community leaders and related communities. For drones in 2019 there were 8 reports, 2019 decreased to 6 reports, and 2021 again decreased to 4 reports [21].

c) If DKPPU issues a new regulation regarding SUAV, then there will be socialization for the SUAV community in the form of online and offline. For example, the Indonesian Drone Pilots Association (APDI) is always invited to these activities.
d) AirNav Indonesia disseminates education through social media Instagram which has 25,600 followers as of 11/08/2023.


*Figure 6. UAV campaign with certified remote pilot* [28]


*Figure 7. Efforts to control illegal drones by Airnav Indonesia* [29]

## 4. CONCLUSION

Based on the research conducted by the authors, the authors draw the following conclusions:

A. The operation of SUAV at the Airport KKOP is considered dangerous; there needs to be control through appropriate mitigation measures.

B. There are 7 SUAV reports operating at KKOP Soekarno Hatta International Airport, which are included in the hazard category. The results of SUAV's safety risk management at KKOP Soekarno Hatta International Airport are remote (3) and hazard (B) which are included in the tolerable index (3B).

C. There are two elements in Safety Promotion, namely:

a) Training and Education

Airnav Indonesia through the Directorate General of Civil Aviation, has eight lists of affiliated SUAV training centers, then disseminates education through social media.

b) Safety Communications

JATSC coordinates with the Airport Authority Office Region I regarding the findings of illegal SUAV operations, AirNav Indonesia cooperates with stakeholders to be able to work together to ensure flight safety.

D. This research is expected to contribute ideas for all Aviation Training Providers to carry out the mandate of the law in synergy to build a long-term and sustainable safety system.

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