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DETERMINATION OF FACTORS THAT CHALLENGE AND FACILITATE THE PROCESS OF TRANSITION TO SAFETY MANAGEMENT SYSTEMS (SMS) IN NIGERIA AIRLINE OPERATIONS.

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ABSTRACT

This research is aimed at determining the factors that challenge and facilitate the process of transition to safety management systems(SMS) in Nigeria Airline Operations. This consideration was established to help in enhancing standardized methods of application and enforcement of maintenance and repairs operations for commercial Airline carriers. This research adopted a quantitative research technique with cross-sectional survey as research approach. However, in eliciting responses from professionals, 201 aviation maintenance and management professionals were sampled from 4 maintenance and repairs operation units and 5 Airlines/approved maintenance organizations at Owerri Airport Imo State Nigeria. Semi-structured questionnaire was used for data collection while these data were analyzed using descriptive statistics (mean, standard deviation) and inferential statistics (principal component analysis (PCA)) through Statistical package for social sciences (SPSS) version 23, for ease of computation. This research finding show that high operating costs, multiple charges and inadequate communication channels for reporting safety concerns or incidents are factors that hamper the adoption of safety management systems in aviation industry in Nigeria. This research therefore recommends that regulatory authorities and industry associations can foster a culture of collaboration and provide platforms for knowledge dissemination.

Keywords: Evaluation, Safety Management System**,** Aviation, Maintenance, Organization.

BACKGROUND INFORMATION

Air transport is arguably essential to the globalization taking place in many other sectors, as it promotes economic development, commerce, foreign investment and tourism(Kankaew, 2022). On average, over the years, travel for different uses has risen strongly globally with around 4.5 billion people using air transport in 2022 and the annual number of passengers has increased by 8.9% since 2019 (ICAO, 2022), reflecting the domination of the industry and a need for its productive operations and profitability as this trigger the need for airline safety.

Early in the new millennium, the Safety Management System (SMS), a key method to safety management, was introduced with the goal of enhancing the safety of air transport operations and maintaining these operations at acceptable levels of risk (Zimmermann & Duffy, 2023).Even

though flying is currently the safest form of transportation, there have nevertheless been incidents and fatalities in the industry (Hook, Sizoo & Fuller, 2022). Aviation accidents have not yet been prevented, as evidenced by the crashes in Tazania in November 6 2022 with Precision Air Flight 494, an ATR 42-500 flying a domestic flight from Dar es Salaam, crashing into Lake Victoria while attempting to land at Bukoba Airport, Tanzania, in which of all the 43 people on board, 19 are killed (Aviation report, 2023); in August 23, 2023 where an Embraer Legacy 600 crashes in Oblast, Russia killing all of the 10 people on board, including Wagner Group leader Yevgeny Prigozhin (Aviation Report, 2023).
Coming to Nigeria there have not been recent commercial plane crash in last seven years, however on November 14, 2023, at least 62 passengers escaped death on Tuesday as an aircraft belonging to Nigerian airline, Value Jet skidded, off the runway at the Port Harcourt International Airport in Rivers State (Channels News, 2023). **Also** on the evening of 21 May 2021, a Nigerian Air Force Beechcraft King Air 350i with Ibrahim Attahiru and ten other occupants were on a visit to the northern state of Kaduna to attend a Nigerian Army recruit passing out parade the following day (*The Guardian Nigeria*, 2021). During the flight the aircraft crashed killing all on board including Attahiru. Thus the last major commercial plane crash was with Dana Air Flight 0992. Dana Air Flight 0992 was a scheduled Nigerian domestic passenger flight from Abuja to Lagos, Nigeria. On 3 June 2012, the McDonnell Douglas MD-83 aircraft serving the route suffered a dual-engine failure during its approach to Lagos. It failed to reach its intended destination and crashed onto buildings, killing all 153 people on board and six on the ground (Seeger & Auer, 2016). With 159 deaths, it remains as the deadliest commercial airliner crash in Nigerian history since the Kano air disaster in 1973 (*Gambrell, 2012).*

Consequently, according to Yang, Chang and Lin (2023), SMS is an approach to safety management that has been placed in order to increase safety of aviation operations and to sustain these activities at appropriate standards of risk. Early in the new millennium, aviation authorities realized that only adhering to laws and regulations was insufficient to ensure safety. As a result, they adopted SMS, which was the outcome of an approach to safety management that was considerably different from previous method (Malakis, Kontogiannis & Smoker, 2023).SMS speaks to the need for a proactive culture of protection by attempting to identify the underlying causes of accidents, refraining from taking a denouncing stance (Şimşek & Ünal, 2022). SMS's main objective is to make people safer in everyday situations. SMS encourages all workers to view safety as a priority and to take all actions in flight operations that are focused on this priority, which is substantially different from old-school safety procedures (Malakis, Kontogiannis & Smoker, 2023

According Shneiderman(2022), aviation safety monitoring is moving away from being an industry best practice and toward becoming a regulatory requirement. This is focused on the belief that risks to safety will still occur. Identifying and handling risks before accidents or events occur is a critical aspect of maintaining protection. According to Settembre-Blundo et. al. (2021), the effectiveness of a Safety Management System is based on how deeply it permeates the organization. Regulatory organizations are also quite interested in how SMS contributes to ensuring safety. Similarly, several countries' civil aviation authorities (New Zealand, Nigeria, China, etc.) are taking steps to improve the industry's safety as a result of past incidents and incident-related problems (Kaspers et. al., 2019).

Problem Statement

The adoption of SMSs transformed aviation safety management from an industry best practice to a legislative mandate (Stolzer, Sumwalt & Goglia, 2023). As a result, aviation authorities are expected to create new ways to describe the sector's safety management operations, and the industry must establish means to certify compliance with the requirements (Stolzer, Sumwalt & Goglia, 2023). Several countries have gone from conventional modes of safety surveillance carried out by a vast number of product checks to safety surveillance based on SMS tracking using safety efficiency metrics (Leib & Lu, 2013;Shekari, 2020; Bugayko & Ierkovska, 2021; Kešeľová et al., 2021; Korkmaz, Filazoglu & Ates, 2023) In this context, SMSs emerged as a collection of safety-related activities that enabled an agency to carry out its responsibilities along the continuum of self-regulation (Ellis et. al., 2022). This transformation has created difficulties for an organization that must now effectively self-regulate as well as for a regulator who must now gauge the effectiveness of a mechanism rather than monitor adherence to a prescriptive regulation (Ellis et. al., 2022).

The organizational responsibilities and duties outlined in the ICAO Framework that form the foundation for SMS's successful functioning are not well understood in Nigeria's aviation industry (Aruwa, 2019). In order to address the inadequacies of the present SMS demand, the prevailing impression is one of dependence on the robustness of the quality control system and on the adaptability of the maintenance operations (Adjekum & Tous, 2020)

Previous studies by Chinonso and Ejem (2020) shows that even airport service quality (ASQ) in Nigerian airports is now low, suggesting that the service quality expectations of the airlines and passengers are not being effectively met. Thus if the airport service quality is low that tells of the nature of the SMS quality in use among airlines. However, identifying the problems in the SMS implementation process is critical to improving SMS performance. Appropriate solutions should be created to ensure SMS success. For example, the Nigerian aviation sector has not yet fully transitioned to SMS (Tyagi, Tripathi & Bouarfa, 2023), and the danger is that passenger traffic rose by more than 40% in 2021, from 9,069,295 to 14.2 million (National Bureau of Statistics, 2021). In 2022, 37 airlines flew over Nigeria, with 26 airlines running 13,003 foreign flights and 11 airlines operating 80,328 domestic flights (Okeke-Korieocha, 2023).This is a cause for concern, as safety hazards are anticipated to rise in tandem with the dramatic increases in passenger volume. It was not until 2020 that the Accident Investigation Bureau Nigeria (AIB-N) has affirmed readiness with partners to implement Safety Management System (SMS) to enhance aviation safety. Hence a comprehensive review of the implementation of the SMS and it interfaces with current maintenance and quality control activities are necessary (Kešeľová et. al., 2021).

Objectives of the Study:

1. To determine factors that challenge and facilitate the process of transition to safety management systems (SMS) in Nigeria Airline operations.

Research Questions

What are the factors that challenge and facilitate the process of transition to safety management systems (SMS) in Nigeria Airline operations?

Research Hypotheses

HO_1: The identified factors collectively do not significantly affect the process of transition to safety management systems (SMS) in Nigeria Airline operators

HO_2: The identified factors individually do not affect the process of transition to safety management systems (SMS) in Nigeria Airline operators.

Justification of the study

The findings of the study might give significant information that aviation stakeholders can use to enhance Nigeria's aviation safety record. The findings may be used by the Ministry of Aviation to evaluate aviation rules and policies in order to instill an aviation safety culture. Donors and international aviation authorities may be able to utilize the study's findings to identify and implement programs suited to specific issues in Nigerian aviation safety. The findings and suggestions of this study might be used as a reference for researchers, academia, and aviation stakeholders.

In comparison, many aviation organisations did not formally evaluate and track safety risks prior to the implementation of the SMS. They relied upon a more intuitive, if any, approach. They reported accidents/incidents but did not look at past human error or equipment failure for causal/contributory causes.This research would aim to strengthen working relationships with management and workers inside and between them, and to improve collaboration and problem solving in the aviation industry.

Concept of Aviation Safety

While aviation is one of the world's safest modes of transport today, accidents are still happening (Zhang & Mahadevan, 2021). It is necessary for one to see that they nevertheless exist no matter how often someone attempts to avoid an accident. In order to stop as many as possible, what is necessary is attempting to formulate a plan of action. "The simplest definition of safety, according to Merriam-Federal Highway Administration (2012), is "the state of being protected from damage, injury, or failure" or "a system (like a firearm or a machine) designed to avoid inadvertent or unsafe activity.

According to Roland and Moriarty's paper submitted to the Aeronautical Science Institute entitled 'Engineering for Safety' came in 1947 as a first form of safety idea, which states that "Safety must as well be planned and implemented in aircrafts as is performance, and that it is the first form of safety principle, as indicated by Zhang and Mahadevan (2021). A manufacturer's organizational structure must prioritize safety just as much as tension, aerodynamics, or a set of weights.

It is also new to have safety as a specialty, in contrast to other disciplines that have been established for some timeZhang and Mahadevan (2021).Many safety professionals who are currently pursuing careers in safety and accident prevention initially planned to pursue certification in prevention. Years ago, anyone could work in accident prevention, but today it is a more rigorous profession that calls for people to be trained in specific disciplinesZhang and Mahadevan (2021). In this country, accidents occur everyday. Some are fatal, like an airline crash, and others are non-fatal, like a broken leg. By actually introducing a Safety Management System, more accidentscan be avoided.

Concept of Aircraft Maintenance

Aircraft mainteanace is a continual operation that is dynamic, systematic and continuing. The entire aircraft must be tested, maintained, updated and the required sections removed by supervisory authorities such as CAA, FAA, JAA, CEMILAC, RCI etc. to meet the international standards mandate (Sprong et.

al., 2020).In general, after a predetermined amount of time or flying hours/flight cycles, aircraft are expected to be maintained with correct performance monitoring in all components, sub-assemblies, rotables, shelf-life parts, and line maintenance systems (Sprong et. al., 2020). Any parts or items used in aircraft will have a fixed life restriction (flight cycle or shelf life) and will be replaced as soon as they reach those limits. Because of their Shelf Life/Flying Period expiry, many aircraft components have to be replaced and several other parts are to be inspected for snags in compliance with flight safety requirements (Habib and Turkoglu, 2020). Below are usually the various routine repair activities undertaken.

a) Aircraft cleaning and its primary Avionic elements.
b) Cleaning and examination of components of Shelf Life as per the Preparation Standard (SOP)
c) Maintenance of Avionics
d) Application of compound prevention against corrosion
e) Lubrication and overhaul parts.
f) Draining of leaking fluids and testing of fuel systems trouble shooting
g) Hydraulic and pneumatic equipment repair
h) Replacing rotables and LRUs in compliance with recommendations
i) General wear and tear inspection and verification

Avionics Servicing is a primary area of maintenance for aircraft which deals with electrical and electronic systems(Gyazova&Vlaznev, 2020). For the survival of the aircraft, these pieces are important. Avionics navigation and communication systems, including as radars, sensors, computer systems, radio communications, and GPS management, require meticulous analysis(Gyazova&Vlaznev, 2020). A solid understanding of electrical wiring, looming, and technical abilities are required for job in avionics maintenance. In order to maintain the professionalism of the SMRO team and IAI as an organization in particular, it is imperative that the entire aircraft maintenance operation be carried out professionally(Gyazova&Vlaznev, 2020).
The 'International aviation Advisory Circular' explains why the aviation maintenance program must achieve specific safety objectives for aircraft and passengers. The following specific objectives are set forth in the maintenance manual: (a) ensuring that every aircraft issued for service is airworthy and has been properly maintained for air transport operations; (b) ensuring that all maintenance and alterations performed by the aircraft's owner or other persons are in accordance with the maintenance manual; and (c) ensuring that only qualified personnel with the necessary facilities and equipment can perform maintenance (Federal Aviation Administration, 2008).
The International Aircraft Safety Advisory Circular 120-16E lists "ten items" that must be included in each airline maintenance program.

Table 2.1: Ten Elements of Air-Carrier Maintenance Programme (FTA, 2008)

10 Elements of Air-carrier Maintenance Programme as per ASAC 120-16E
1) Airworthiness responsibility
2) Air carrier maintenance manual
3) Air carrier maintenance organization
4) Accomplishment and approval of maintenance and alterations
5) Maintenance schedule
6) Required Inspection Items
7) Maintenance recordkeeping system
8) Contract maintenance
9) Personnel training
10) Continuing Analysis and Surveillance System (CASS)
Source: International Aircraft Safety Advisory Circular 120-16E

Implementation of SMS

There are various approaches to incorporating any new curriculum or new mission. Several international airports that have effectively introduced safety management programs have done so with the use of three separate deployment techniques, including:

- Evolutionary Form
- Staggered approach to methodology
- Rapid Monitor Adoption (Transportation Research Board, 2007).

It takes many years to complete this approach, but it allows for the gradual development and promotion of the safety culture necessary for an efficient and effective SMS (Transportation Research Board, 2007). The Evolutionary Style is the first step that an airport should take to incorporate SMS. Although it doesn't appear that the US is using this technique, it is the most effective way to carry it out. It's simpler for the airport to really grasp SMS, establish a good SMS policy, and convince staff to embrace it if SMS is incorporated over time. The phase methodology approach is the next step in the implementation process (Transportation Research Board, 2007). By setting deadlines, it is focused on reaching targets (Transportation Research Board, 2007). Prior to moving on to the next SMS component, it sets the airport timelines by which activities must be performed, which aids in resolving difficulties. The last route to adopting SMS is Quick Track Adoption (Transportation Research Board, 2007).Because the airport is given the directives and each step' implementation begins right away, this is the least preferred process.This method complies with ICAO and FAA regulations, however it does not allow for appropriate integration and is excessively violent, posing a threat to safety and company culture (Transportation Research Board, 2007). This is not a tactic that ought to be used to SMS or any other new software.

There are active SMS systems in existence at several international airports, and these systems offer many benefits. During the implementation phase at airports abroad, the Civil Aviation Authorities (CAAs), who are the international counterpart of the FAA, have permitted airports to adopt various strategies (Transportation Research Board, 2007). The method and gap analysis is the techniques used by airports, enabling airports to look at safety procedures in operation and do a gap analysis that identified shortcomings (Transportation Research Board, 2007).The Evolutionary Style was the implementation technique which they felt performed well (Transportation Research Board, 2007). Certain international airports found it helpful to develop each component fully without rushing through a component, which appears to be the most effective approach to carry it out.

The next procedure is the compilation of records, which is known to be the foundation of SMS, which helps the whole board to provide a centralized database. Hazard-Reporting Mechanisms is another mechanism that facilitates anonymous and transparent reporting, allowing any individual to report any safety concerns without being detected or scolded when reporting a problem (Transportation Research Board, 2007). The honesty of a strategy is a critical factor of making SMS work effectively.Occasionally, however, outside organizations such as the National Transportation Safety Board (NTSB) carry out assessments to guarantee employee privacy by sealing their identities from opportunities such as being disciplined for reporting or causing conflict.

A number of airports, including those in Australia, Canada, Hong Kong, Ireland, Italy, Kuwait, Singapore, Switzerland, the United Kingdom, and others, have implemented SMS as the most efficient method for preventing accident rates from increasing at the same time as anticipated global air traffic increase (Transportation Research Board, 2007).

Benefits of SMS

It's critical to keep in mind that "there will always be hazards and risks in the airport environment." Before these safety issues become accidents, careful management is required to identify and monitor them(Transportation Research Board, 2007).Airports would definitely benefit from SMS in many ways, despite being able to completely eradicate all hazards. First of all, SMS should be employed in routine job tasks and should not be a burden to any staff members.SMS can make it easier to evaluate airport incidents and casualties and provide input for an overall increase in airport safety and performance. According to the Transportation Research Board, (2009) the SMS strategy reduces losses, boosts productivity, and is generally advantageous for business.

Reduced cost, both directly and indirectly, is another major advantage. Although SMS expenses for initial deployment and other costs for continuing preparation will be borne, if airport staff are trained to detect early signs of accidents and crash, they will usually be substantially decreased. A productive SMS leads to good corporate ethics and contact between top management and each individual citizen (Transportation Research Board, 2007).In addition, SMS helps airports maximize the effect of safety investments to ensure that the highest priority requirements are recognized" and "create a safety culture through improving awareness of safety and risk among airport personnel" (Transportation Research Board, 2007). Establishing a culture of excellent safety procedures, learning from incidents, and raising overall standards are all advantages (Transportation Research Board, 2007).

THEORETICAL FRAMEWORK

Theory of Human Error in Aircraft Maintenance

Norman proposed this theory in 1981, in which he claimed that one basic fact of human experience is that people make mistakes(Muecklich et. al., 2023). This propensity to make mistakes is so pronounced and pervasive that we all expect that there would be mistakes. It is claimed that there is no such thing as error-free human activity from the viewpoint of human factors (Tretten& Normark, 2019). The nature of human errors has intrigued researchers and many different forms of errors are being studied, especially in the maintenance work area.We could argue that the inability to execute the intended action is a mistake and this may be caused by inattention, poor judgment or indifference. Reason, Manstead, Stradling, Baxter, and Campbell (1990) describe errors as the failure of planned activities to attain their intended consequences(Tretten& Normark, 2019). It might include two types of mental straying: the 13 unintentional divergence of action from objective (slips and lapses), and the departure of planned activities from any acceptable route to a desired destination (errors)(Tretten& Normark, 2019). According to some estimates, 84-94 percent of accidents are caused by some sort of human mistake (Kelly & Efthymiou, 2019).Various forms and categories of mistakes exist. These contain commission errors and omission errors, errors dependent on abilities, faults and breaches. Among the various forms listed above, there are separate groups. Skill-based mistakes are mistakes that result because the actions taken are not carried out as expected. That include drops, lapses, fumbles, trips and (Kelly & Efthymiou, 2019). When you fail to carry out an action, a slip is where the action is not what was expected and a loss is linked to recollection. A trip is a forced interruption of an existing motor program, whereas a fumble is an improperly executed motor program. In several tests, human mistakes were assessed using Rasmussen's (1986) hierarchical categories of skilled-based action, rule-based behavior, and knowledge-based behavior. Skilled-based action "represents sensorimotor performance without conscious control" (Kelly & Efthymiou, 2019).In familiar job environments, rule-based behavior occurs and it is governed by the implementation of rules. In new or unknown contexts, knowledge-based behaviour occurs and behaviour is driven by interpreted knowledge, logic and preparation. Out of 200 operating difficulties in nuclear plants, Kelly and Efthymiou (2019) found that 16.5 percent were due to skill-based error, 51 percent were due to rule-based error, and 22.5 percent were due to knowledge-based error. In Australia, professional behavior accounted for 54.8% of human mistakes that resulted in fatal industrial injuries, followed by rule-based behavior (13.6%) and knowledge-based behavior (13.7%)(Yeow et. al., 2020).In their study, this research used the SRK model of Rasmussen and primarily used the methods of a survey. Research to investigate the impact of human error in industrial accidents was undertaken by Salminen and Tallberg (1996). Data were collected from 99 fatal occupational accidents in Southern Finland in 1988 and 1989 as well as 178 fatal workplace incidents across Finland between 1985 and 1990. The ladies and men who took part in the study varied in age from 25 to 44 years old and had been injured in accidents. The employees were questioned about the injuries they had sustained. Work roles and phases have been classified (Kelly & Efthymiou, 2019). Rasmussen's (1986) SRK model was utilized to interpret the impacts, which included ability, rule, and knowledge-based mistakes, as well as technical flaws.The data show that different types of errors result in different types of fatalities and injuries. In fatal occurrences, skill-based mistakes (66 percent) and rule-based errors (18 percent) were more prevalent, whereas knowledge-based errors and technological flaws were found to be extremely rare. According to the writers, the sort of mistake that occurs relies on the mission's scope (Kelly & Efthymiou, 2019).Thestudy, however, struggles to identify whether these individual mistakes are contributing factors. Significant accidents can usually be triggered by human errors or flaws, mechanical flaws or external factors, it can be argued.

They almost all originate from a multitude of factors, including maintenance workers, managers, administrators, and buildings. In general, technological problems result from human mistakes such as inadequate maintenance, overloading or incorrect use. Therefore, more focus should be paid to figuring out why and avoiding individual faults and errors at all stages. On that note, the focus would be on errors and breaches.

Mistakes: There are additional types of failures that are classified as flaws. Training is linked to mistakes. "Actions can occur exactly as planned," the argument goes, "but the plan by itself is insufficient to accomplish the desired effect" (Pryimak et al., 2020). Higher-level mistakes are associated with the plan's conception. Based on the level of output at which they occur, errors can be divided into two categories. This includes both law-based and knowledge-based mistakes (Dyer, 2020). "Failures in selecting or using these rules for issue solutions are known as rule-based mistakes" (Dyer, 2020). Mistakes can involve the application of a poor rule or the misapplication of a generally excellent rule that has been rendered ineffective due to local circumstances. "Knowledge-based mistakes are defined by the requirement to address new issues for which the individual does not have pre-packaged "codes" and must thus devise a first-principle solution" (Dyer, 2020).

Violations: Errors represent individuals' emotional and physical behaviors that struggle to accomplish the desired result(Pryimak et al., 2020). Not unexpectedly, these events dominate most event records, including the fact that human beings make mistakes for their own existence. Offenses, on the other hand, are far less common and involve willful disregard for rules and regulations. Willful, but not intrinsically immoral, departures from specific processes deemed necessary to guarantee the safe operation of a potentially dangerous equipment are referred to as violations (Zavila et al, 2021).There are other ways to distinguish between different sorts of infractions, such as routine violations and situational violations, such as when someone makes a mistake (Zavila et al, 2021). Routine infractions are part of the day-to-day job and are committed to completing the task effectively; the employee does not follow all of the protocols in place to complete a mission. Situational breaches are unusual infractions that occur as a result of a specific set of circumstances or a unique scenario (Key et al., 2022). According to Bernard et al. (2020), "the principle of least effort is the dominant factor on human behavior," and this infringement may be "proven at the skilled-based level of performance."Situational breaches are caused by a mismatch between job conditions and policies. For example, the procedures you need to follow do not apply to the scenario you're in at work, so you just get the job done without enforcing specific regulations (Bernard et al., 2020). The most significant adjustment that has to be made is that defects are detected in connection to an individual's mental processes; mistakes can only be interpreted in terms of the social environment in which the activity is governed by operational procedures, codes of behavior, and expectations (Bernard et al., 2020).According to Pryimak, Orlovskyi and Tretyakov(2020), aviation repair technicians engage in an abnormally large number of dangerous tasks. The two most common violations were installation and failure to follow norms and directions. Fixed for this, which entails finding a new way to perform some activities that differ from the service manual procedures. In some situations, the "I know best" attitude may be highly useful, but it also has the potential to be disastrous (Pryimak et al., 2020). That may be a point of contention in the trial, not just a rule violation (i.e. the inability to follow a rule or procedure). The research done by Zimmermann and Mendonca (2021) shows that a lot of research has been done on the issues listed above. They looked at whether maintenance safety event activity might be predicted based on self-reported hazardous acts. To examine the patterns of risky acts performed by aviation maintenance personnel, a maintenance activity questionnaire was designed. They stated that breaches and mistakes were strongly connected to occurrences of injuries that endangered the quality of aircraft maintenance but were unrelated to workplace damage. Skilled errors were linked to work-related injuries rather than work-quality accidents. We may argue that their study (Zimmermann and Mendonca, 2021) has a flaw in that it does not explain how skill-based mistakes lead to work-related injuries in depth; they just provide a summary but do not participate in a causal interpretation. The purpose of this study is, therefore, to look at the operator's theories, attributions and motives for the causes of these accidents and what impact, if any, human error can make.

EMPIRICAL REVIEW

Survey results were used to determine employees' expectations of the safety management system (SMS) implementation of the Approved Maintenance Organization (AMO) in the aviation industry in a study by Uhuegho, Okafor, and Steve (2013) on the safety management system implementation evaluation of the Approved Maintenance Organization: a case study of Nigerian pilots. In Nigeria, AMOs have served as a case study. The findings show that more than 80% of the population considered for this investigation complied with SMS deployment plans. However, the results showed a lack of safety management knowledge, planning, and inspiration—essential elements that influence how all safety management operations are carried out (Majid et al., 2022). In addition, the findings indicate a lack of capacity to analyze the danger associated with the defined hazards.The main methods for monitoring the AMO's safety performance are external audit and safety investigations (Zimmermann & Duffy, 2023).The Chi-square coefficient was used for the fictitious test. The results show that there is no strong correlation between the management's contribution to the AMO safety management framework and the hiring of key personnel. Overall, the findings show that AMO wishes to improve the use and understanding of SMS inside the AMO.

In addition, a study by David-Cooper (2014) on the introduction of safety management programs in aviation: the regulatory effect on Canadian Commercial Air Carriers demonstrated that Canada's interest in ensuring passenger safety has shifted to the review of operational aspects to improve the safety of the industry in light of numerous significant aviation incidents at the end of the 20th century(Zimmermann & Duffy, 2023). Since the International Civil Aviation Organization (ICAO) recently implemented safety management systems (SMS), air carriers licensed in Canada are now required by law to manage the impact of their corporate choices on the degree of safety of their operations. His research sought to, first, objectively evaluate the safety management theory and, second, assess the legislative framework imposed on Canadian carriers using SMS. It is a survey of the literature that has taken a critical look at the practical and legal difficulties Canadian operators experienced when switching to SMS. It also addressed the legal barriers preventing SMS data security from being made public or subject to civil litigation. The study comes to the conclusion that until this revolutionary protection system is completely functioning around the world, the SMS Treaties will examine the potential benefits and potential flaws that might develop in specific areas of the law. Although SMS can effectively reduce safety risks by quickly responding to industrial dangers, it is vital to examine any current flaws that can limit this program's ability to effectively lower accident rates. In light of the fact that Canada was the first nation in the global aviation community to adopt and implement SMS, his report proposed legislative measures that would deter ICAO Member States from experiencing the same difficulties as a number of Canadian carriers(Zimmermann & Duffy, 2023).

The International Transport Forum (2017) wrote a paper on Overcoming Obstacles to Implementing SMS. Their article addresses the challenges of implementing SMS and provides real examples of how to overcome them in leading nations, notably ITF member countries, across all modes of transportation (air, marine, rail, and road). The challenges and problems with SMS implementation might stem from an organization's or occupation's unique cultural characteristics (Chan & Li,2023). Cultural characteristics can either help or hinder the adoption of a safety management system. The challenges and issues in establishing safety management systems might be overcomed if cultural characteristics were well understood. Employees' knowledge and skills should be used more intensively in the implementation process to avoid unique cultural elements becoming a barrier to adopting safety management systems. The discovery, discussion, and implementation of possible safety concerns at all levels of the organization would be key facilitators for safety improvements. In safety management, and particularly in event reporting, new thinking is required. The development of a strong safety culture in the workplace may be facilitated by emphasizing the positive human elements of work and acknowledging people as a resource for effective performance(Chan & Li,2023). With only its own resources, no firm can adequately implement the safety management system. Companies must work together, and regulatory bodies must encourage this cooperation. The voluntary co-operation programs of the industries have shown to be successful and beneficial in overcoming any difficulties that may arise during the installation of safety management systems.

RESEARCH DESIGN

In this study, a survey research design will be used. According to Gupta and Gupta (2022), this approach involves interviewing a sample of people or giving them a questionnaire in order to collect information. The primary purpose of the survey research design is to use questionnaires to determine the fundamental characteristics of a large number of people, objects, or things. The design would also be utilized to help the researcher collect information from sample participants in order to calculate population parameters because to its descriptive character. When a researcher wishes to establish specific facts regarding the issue, Siedlecki (2020) advises using a descriptive research approach.

The information will be gathered in order to determine the SMS implementation level inside the MRO for Nigerian airline operations. Additionally, a pilot sleepiness detection system will be developed utilizing Python Ajax programming and Computer Vision.

POPULATION OF THE STUDY

The whole group of people that the researcher wished to study makes up the population of the study(Bloomfield & Fisher, 2019). The AMO of Nigerian airline operators operating domestic and international flights in the registration of the Nigerian Civil Aviation Authority (NCAA) would be the population examined in this research. It will be made up of a variety of experts and workers from Approved Maintenance Organizations (AMOs) in the Nigerian aviation industry. An exhaustive population will be present that would bypass these experts.

SOURCES OF DATA COLLECTION

The topic of this study makes clear that the necessary data were gathered from primary and secondary sources.

DATA ANALYSIS METHOD

The methods to be used are simple percentage, factor analysis, t-test and canonical correlation(Mishra & Alok,2022) The simple percentage approach will help to evaluate the profiles of respondents and other related issues that have addressed study objectives.

Factor Analysis (Principal Component Analysis)

The criticality, ranking, and qualities of the elements to be evaluated are determined using the renowned dimensional reduction method known as exploratory factor analysis (Schreiber,2021).

Principal Component Analysis, or PCA, is a dimensionality-reduction method that is often used to reduce the dimensionality of large data sets, by transforming a large set of variables into a smaller one that still contains most of the information in the large set (Schreiber,2021).
So to sum up, the idea of PCA is simple — reduce the number of variables of a data set, while preserving as much information as possible.

Step 1: Standardization

The aim of this step is to standardize the range of the continuous initial variables so that each one of them contributes equally to the analysis.

Mathematically, this can be done by subtracting the mean and dividing by the standard deviation for each value of each variable.

$$z = \frac{value - mean}{standard\ deviation}$$

Once the standardization is done, all the variables will be transformed to the same scale.

Step 2: Covariance Matrix Computation

The aim of this step is to understand how the variables of the input data set are varying from the mean with respect to each other, or in other words, to see if there is any relationship between them. Because sometimes, variables are highly correlated in such a way that they contain redundant information. So, in order to identify these correlations, we compute the covariance matrix.

The covariance matrix is a $p \times p$ symmetric matrix (where p is the number of dimensions) that has as entries the covariances associated with all possible pairs of the initial variables. For example, for a 3-dimensional data set with 3 variables x, y, and z, the covariance matrix is a 3×3 matrix of this from:

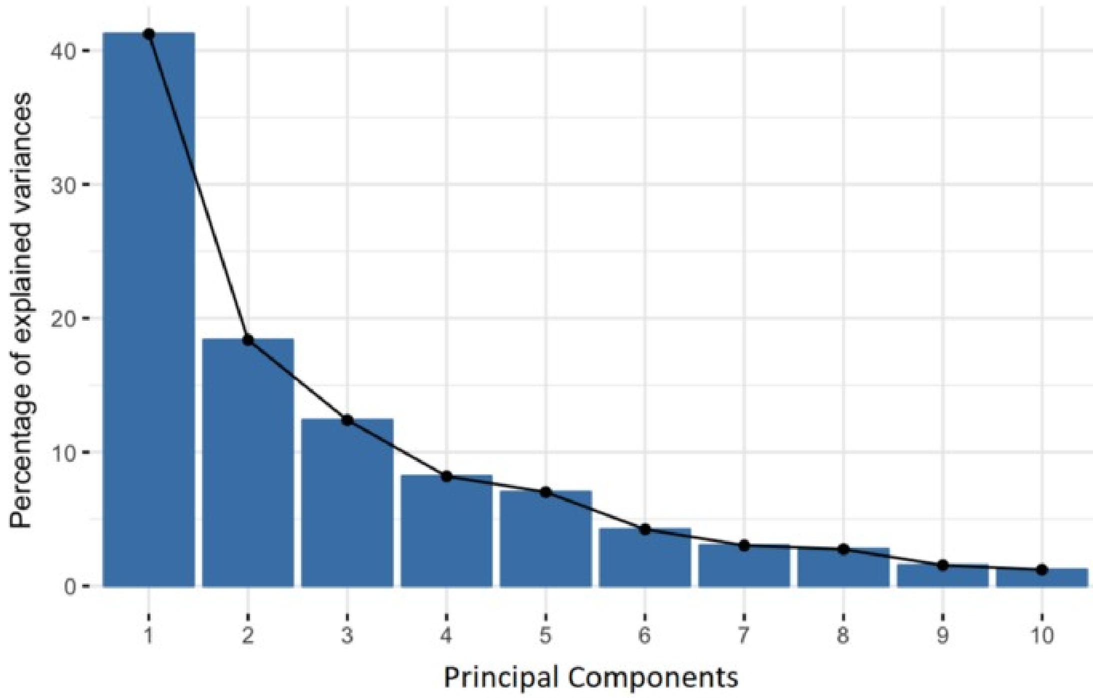
$$\begin{bmatrix} Cov(x,x) & Cov(x,y) & Cov(x,z) \\ Cov(y,x) & Cov(y,y) & Cov(y,z) \\ Cov(z,x) & Cov(z,y) & Cov(z,z) \end{bmatrix}$$

Covariance Matrix for 3-Dimensional Data

Step 3: Compute the Eigenvectors and Eigenvalues of the Covariance Matrix to Identify the Principal Components

Eigenvectors and eigenvalues are the linear algebra concepts that we need to compute from the covariance matrix in order to determine the *principal components* of the data.
Principal components are new variables that are constructed as linear combinations or mixtures of the initial variables. These combinations are done in such a way that the new variables (i.e., principal components) are uncorrelated and most of the information within the initial variables is squeezed or compressed into the first components. So, the idea is 10-dimensional data gives 10 principal components, but PCA tries to put maximum possible information in the first

component, then maximum remaining information in the second and so on, until having something like shown in the scree plot below.



Principal component analysis will be used to reduce the factors indicated by the respondents in a predictive regression models in order to show the factors that have similar patterns of ratings. However this will be done using Statistical Package for Social Sciences (SPSS) version 23 for ease of computation.

Identified Factors to be tested

ID	**Factors**
EC	Expertise Constraint
RF	Regulatory Framework
FC	Financial Constraints
ICB	Industry Collaboration and Benchmarking **.**
OC	Organizational Culture
PA	Poor Awareness
CI	Complexity of Integration**.**
DCA	Data Collection and Analysis
CR	Communication and Reporting
LSC	Lack of Senior Management Commitment
HTP	High Turnover of Personnel
HIR	High Interest Rate
HOP	High Operating Cost and Multiple Charges
MF	MRO Facilities.
PSR	Perception of SMS as a Regulatory Burden**.**

Decision Rule

The measurement will take place at a significance level of 0.05. The data analysis will make use of a computer tool called SPSS version 23, which stands for Social Science Statistical Software. The decision rule would therefore be as follows: if the text's effect (p-value) or meaning is less than 0.05, the null hypothesis will be accepted and the alternative hypothesis disregarded; however, if the result is the opposite, the result is deemed to be relevant.

RESULTS:

The field data obtained from the 201 respondents are presented in this section. With the expectation of collecting data with high accuracy, the researcher carefully followed ethics and principles associated with data collection from the participants of various age groups, years of experience, and organization. To unveil crucial findings about the research questions and hypotheses drafted for the study, comprehensive analysis of field data collected using the research instrument for evaluation of safety management systems (SMS) in Nigerian airlines was undertaken. This section presents statistical analyses of the field data with varying statistical tests conducted to proffer solution to the outlined objectives of the study, and to aid valid inferences.

Reliability Results
Scale: All Variables

Table 4.1.1.a Case Processing Summary

		N	%
Cases	Valid	20	100.0
	Excluded[a]	0	.0
	Total	20	100.0

a. Listwise deletion based on all variables in the procedure.

Table 4.1.1bReliability Statistics

Cronbach's Alpha	N of Items
.896	2

A test-retest method was adapted in establishing the reliability of the instrument. Twenty (20) copies of the questionnaire were administered online to twenty (20) aviation maintenance experts in Nigeria found in Linkedin. This is not part of the study population but share similar characteristics. After 20 days, the same instrument was re-administered to the same respondents through Google Form. The results of the two tests was analyzed using Alpha Cronbach reliability test. Nunally (2015) affirmed that result of 0.7 and above is reliable; however our result revealed an alpha cronbach value of 0.896 which means that the instrument is reliable by 89.6%.

Descriptive Characteristics of Respondents

The study explored the bio characteristics of the respondents as presented in the following tables below:

Figure : Gender of respondents

Table : Gender of participants

S/N	Gender	**Freq.**	**Perc. (%)**
1	Male	125	62.2
2	Female	76	37.8
	Total	201	100.0

Source: Field data (2023).

Table 4.1.2a indicates that 62.2% of the sample size were Males while Females made 37.8% of the study participants. It is apparent that Males to a large extent are dominant in the aviation industry.

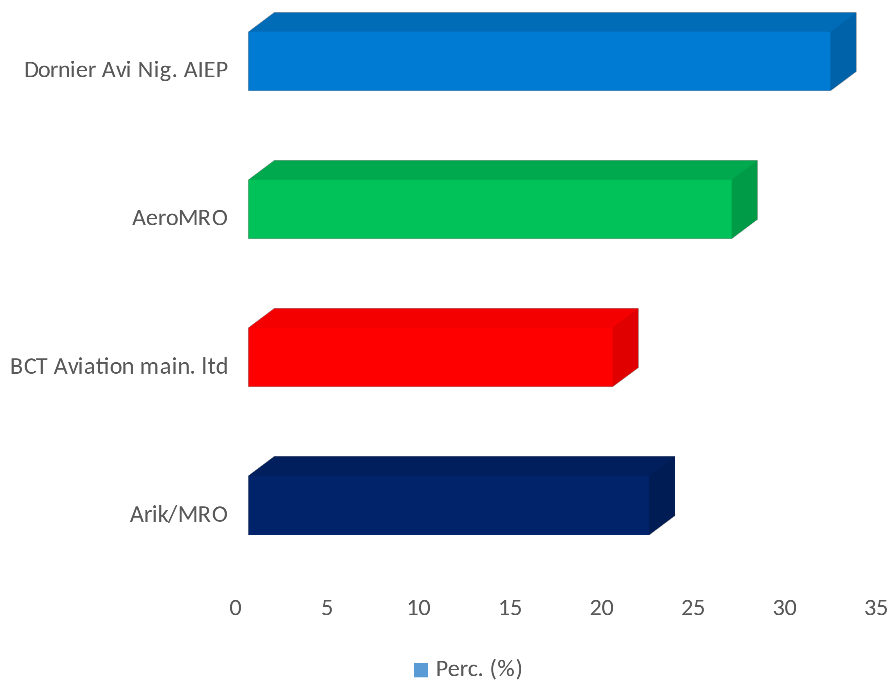


Figure : Aviation maintenance organization

Table : Aviation maintenance organization

S/N	Organization	Freq.	Perc. (%)
1	Arik/MRO	44	21.9
2	BCT Aviation main. Ltd	40	19.9
3	AeroMRO	53	26.4
4	Dornier Avi Nig. AIEP	64	31.8
	Total	201	100.0

Source: Field data (2023).

Table 4.1.2c indicates that 31.8% of the participants are from Domier Aviation, followed by Aero MRO staff (26.4%), Arik (21.9%), and BCT aviation (19.9%) maintenance teams. This statistic shows that the responses are coming from staff of different working conditions and cultures, implying confluence of vast knowledge, which would contribute significantly to the study.

Safety Management Systems in Nigeria Aviation Industry

Table: Awareness level of participantson safety management system regulation in aviation industry

Response	Freq.	Perc. (%)
Yes	186	92.5
Neutral	11	5.5
No	4	2.0
Total	201	100.0

From Table 4.1.3a, 92.5% of the sample indicated an awareness. This depicts a high level of awareness amongst the selected study participants.

Table: SMS implementation in the organization

Response	Freq.	Perc. (%)
Yes	174	93.5
Neutral	12	6.5
Total	186	100.0

Based on the 186 (92.5%) participants who admitted to an awareness of SMS regulation in aviation industry (Table 4.1.3a), SMS implementation is depicted to be on the high side (93.5%) amongst the organizations.

Table: SMS structure with ICAO in the organization

Response	Freq.	Perc. (%)
Yes	147	79.0
Neutral	39	21.0
Total	186	100.0

Result shows a high compliance (79%) of SMS structure with ICAO in the various organizations under study.

Table: SMS implementation

Response	Freq.	Perc. (%)
Yes	143	71.1
Neutral	35	17.4
No	8	4.0
Total	186	92.5

The study also revealed that SMS implementation plan in the organizations is in place, following the indication by the 71.1% of the participants familiar with SMS (Table 4.1.3g).

Factors That Challenge and Facilitate the Process of Transition to Safety Management Systems (SMS) in Nigeria Airline Operations

Table 4.1.5a: KMO and Bartlett's Test

Kaiser-Meyer-Olkin Measure of Sampling Adequacy.		.436
Bartlett's Test of Sphericity	Approx. Chi-Square	713.984
	Df	105
	Sig.	.000

Result in Table 4.1.5a is the Bartlett's Test of sphericity applied to ascertain the adequacy of the correlation matrix. A chi-sqr. value of 713.98 and a KMO value of 0.436 with significance of 0.000 were obtained, implying that the matrix has significant correlations among at least some of the variables, hence the data are appropriate for PCA. A communalities threshold of 0.35 and above was adopted for rationality.

Table: Total Variance Explained

Component	Initial Eigenvalues			Extraction Sums of Squared Loadings			Rotation Sums of Squared Loadings		
	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	2.705	18.030	18.030	2.705	18.030	18.030	2.073	13.818	13.818
2	2.029	13.529	31.559	2.029	13.529	31.559	1.804	12.025	25.843
3	1.545	10.303	41.862	1.545	10.303	41.862	1.688	11.252	37.095
4	1.435	9.570	51.432	1.435	9.570	51.432	1.565	10.436	47.531
5	1.296	8.643	60.075	1.296	8.643	60.075	1.547	10.316	57.846
6	1.166	7.776	67.851	1.166	7.776	67.851	1.501	10.005	67.851

Extraction Method: Principal Component Analysis.

Table 4.1.5b presents the extracted values of the 15 variables denoted as challenging factors to the adoption of SMS in Nigeria Airline operations. As always, PCA was applied to ascertain the hidden significant representatives of the variables, as further supported by the scree plot (Figure 4.8). Using the criterion of retaining only those with eigen values of 1 or greater, the first 6 variables in Table 4.1.5b were retained for rotation. These 6 factors were found to account for the 13.81%, 12.02%, 11.25%, 10.43%, 10.31%, and 10.0% of the total variance, respectively. The remaining 9 factors together account for 32.14% of the total variance. However, communalities of thefactors challenging the adoption of SMS in Nigeria airline operations gave a sum total of 67.85%, which comprises:ASMS26, ASMS29, ASMS32, ASMS38, ASMS33, and ASMS34.

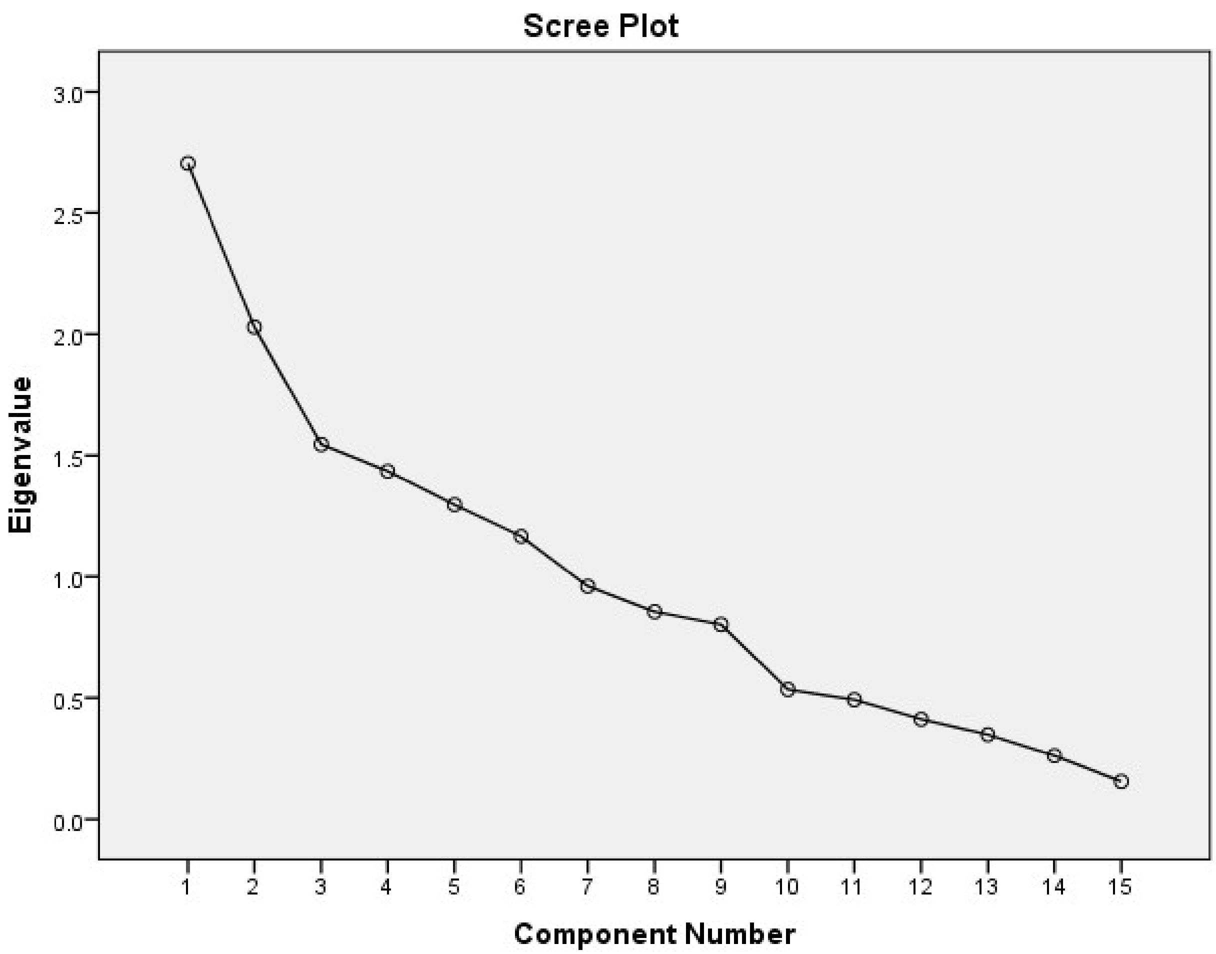


Figure 4.8: Scree plot of factors affecting

Table 4.1.5c: Rotated Component Matrix[a]

	Component					
	1	2	3	4	5	6
Expertise Constraint	.721					
Industry Collaboration and Benchmarking		.838				
Complexity of integration			.671			
High operating cost and multiple charges				.790		
Data collection and analysis					.837	
Communication and Reporting						.867

Extraction Method: Principal Component Analysis.
Rotation Method: Varimax with Kaiser Normalization.
a. Rotation converged in 8 iterations.

Table 4.1.5c has shown the following to be inhibitors to adoption of SMS in Nigeria Airline Operations: lack of highly skilled cross trained staff with both aviation maintenance and IT skills (0.721), lack of collaboration and benchmarking with other airlines or industry stakeholders may hinder the sharing of best practices and the identification of common safety challenges (0.838), complexity associated with integration of SMS into existing operational processes and procedures (0.671), high operating costs and multiple charges, especially in the foreign exchange market (0.790), the limitation in the area of analysis of data(0.837) and inadequate communication channels for reporting safety concerns or incidents which foster delay in real time report, analysis and resolution of safety issues (0.867), respectively.

Results Discussion

Factors that challenge and facilitate the process of transition to safety management systems (SMS) in Nigeria Airline operations

Results revealed the lack of highly skilled cross trained staff with both aviation maintenance and IT skills to be an inhibitor to adoption of SMS in Nigeria airline operations, probably due to the complexity of modern aircraft systems, which rely heavily on integrated avionics and IT systems for operation, maintenance, and safety. Lack of cross-trained staff can result in gaps in comprehending the technical intricacies of these systems, leading to potential safety risks. Also, SMS is known to be heavily data-driven, and therefore relies on accurate and timely data collection and analysis to identify safety hazards and trends. And without individuals who understand both domains, data integration and interpretation might be flawed, impacting the accuracy of safety assessments.

Findings is in agreement with the findings of Seah et al. (2021) whichevinced that the lack of collaboration and benchmarking with other airlines or industry stakeholders may hinder the sharing of best practices and the identification of common safety challenges. This is because, collaboration with other airlines and industry stakeholders allows for the sharing of experiences, lessons learned, and best practices. By learning from each other's successes and failures, organizations can accelerate their SMS implementation, identify potential pitfalls, and avoid reinventing the wheel. Often times, different airlines and stakeholders face unique operational environments and challenges. Furthermore Apostu and Turkoglu (2023) in their study concurred that by collaborating and benchmarking, organizations can tap into a broader range of experiences, which helps in identifying safety risks and mitigation strategies that may not be apparent within their own operations. Collaboration and benchmarking they found can ensure a higher level of consistency and effectiveness in safety management across the industry, thus, leading to the development of industry-wide standards and guidelines for SMS implementation in the aviation industry.

Result further indicated that complexity associated with integration of SMS into existing operational processes and procedures pose a challenge to adoption of SMS in aviation industry. Implementation of SMS require a cultural shift, which is not an easy task, since traditional operational practices might be deeply ingrained, and employees may be resistant to changes in how they approach safety. In agreement, Foster and Adjekum (2023) findings asserts that integrating SMS requires a change in mindset from reactive to proactive safety management, which can take time and effort to achieve. However, the introduction of SMS may disrupt established workflows and procedures, causing temporary decreases in operational efficiency. This might also be a reason SMS implementation has received some degree of reluctance in the aviation industry.

It was also noted that high operating costs and multiple charges, especially in the foreign exchange market, impedes the adoption of SMS in the aviation industry. Considering that implementing and maintaining an SMS requires financial resources, including investment in training, software, data analysis tools, and personnel. Khalef and El-adaway (2023) findings in agreement revealed that if an airline or aviation organization is already facing high operating costs, allocating additional funds for SMS implementation might be difficult. Aviation organizations often have numerous financial priorities, including aircraft maintenance, upgrades, regulatory compliance, and operational expenses. The adoption of SMS might struggle to secure a sufficient budget in the presence of these other financial demands, especially if the cost of implementing SMS is perceived as excessive. These might spike resistance from leadership or stakeholders to allocate funds for it.

Lastly, inadequate communication channels for reporting safety concerns or incidents were upheld as a factor that hamper the adoption of SMS in aviation industry. This was found to infuse delay in real time report, analysis and resolution of safety issues, respectively. This attracted significant concerns, as timely reporting, safety issues might not receive immediate attention and corrective action (Thendu,2023). Of course, delays in addressing safety concerns are known to increase the likelihood of incidents occurring and hinder the proactive nature of SMS.

CONCLUSIONS

Since the surge of SMS regulatory necessity for aircraft safety management, the aviation industry has staggered over new ways of identifying the safety management practices and compliance with the regulations, especially that stipulated in the ICAO framework (Malakis et al., 2021). The current study identified the inhibiting factors that limits the adoption of SMS and proffers solutions to the challenges associated with SMS implementation in the Nigeria aviation industry. Below are the conclusions derived from the findings in the study:

1. There is almost a total compliance to SMS structure in the aviation industry as stipulated in the ICAO framework, with the adoption of a written policy which references the maintenance activities designed to guide in overseeing the day-to-day activities.
2. There is a general plan for SMS implementation, and to a large extent, there is an emergency response strategy which is designed to serve as a contingency plan in the aviation industry.
3. There is an adoption of KPIs comprising number of incidents, accidents, and near-misses, as well as safety-related trends and patterns, deemed to provide quantifiable metrics that help aviation organizations assess their safety practices, identify areas for improvement, and track progress over time. Surveys and assessments are also used by commercial aviation operators, to gauge the safety culture among employees and identify opportunities for fostering a positive safety culture in the aviation industry.
4. The lack of collaboration and benchmarking with other airlines or industry stakeholders and complexity associated with integration of SMS into existing operational processes and procedures pose a challenge to adoption of SMS in aviation industry..

RECOMMENDATIONS FOR PRACTICE

The outlined conclusions clearly spur the following recommendations for the aviation stakeholders, regulatory authorities and organizations at large.
Aviation organizations should actively seek out opportunities for collaboration and benchmarking, since participating in industry forums, conferences, working groups, and safety-sharing initiatives can provide platforms for knowledge exchange. Organizations can also establish partnerships with other airlines or stakeholders to facilitate the sharing of information and experiences related to SMS implementation.
Regulatory authorities and industry associations can play a role by fostering a culture of collaboration and providing platforms for knowledge dissemination. Overall, a collaborative approach enhances the effectiveness of SMS adoption and contributes to safer aviation operations across the industry.

Organizations need a well-structured implementation plan that considers the specific needs and context of their operations. Key strategies include effective change management, comprehensive training programs, clear communication of the benefits of SMS, and gradual implementation to minimize disruptions. Additionally, involving employees in the design and decision-making process can foster ownership and enthusiasm for the new SMS.

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