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Development of an Operational Excellence Framework for Organisational Performance Improvement in the Sudanese Aviation Industry

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Abstract:

Purpose: This study aims to investigate the critical success factors (CSFs) for the successful implementation of operational excellence (OE) by the organisations in the Sudanese aviation industry. Besides that, this study intended to determine the resulted impacts in the improved organisational performance and competitive advantage and quantify the benefits.

Design/methodology/approach: The CSFs of OE were provided and dissected to reveal their integrated components and importance levels. The factors include leadership, people management, continuous improvement, operational strategy, and asset optimisation. The impacts (outcomes) were further categorised into four categories, namely financial results, quality of products or services, efficiency, and satisfaction. The outcome groups were presented, while the weight of each outcome was highlighted.

Findings: With the OE's conceptual framework, the CSFs to achieve OE were identified. From the five main factors, the expert panel members suggested that the leadership factor was the most important factor to achieve OE in the Sudanese aviation industry. Ranking the five CSFs and 40 subfactors provided a better understanding of the Sudan situation, specifically the effective implementation of OE philosophy.

Research limitations/implications: The findings of the subfactors reported in this study were not enough. As a result, future studies must focus on the detailed descriptions of subfactors related to each of the critical factors.

Practical implications: The efficiency in the organisations is generated and enhanced when they become efficient in reducing time wastage, raw materials, and unnecessary processing, and energy used in transportation, storing, and operating plant. Besides, the state of effectiveness is achieved when the organisation achieves its long-term goals through increased customer satisfaction and proves its reason for being. OE is critical as it assures both the efficiency and effectiveness of organisations.

Originality/value: Past research have relatively over-emphasised the unilateral "result-driven" perspective of OE that corresponds with the limited concern for enablers, critical forms, and focus of OE. Thus, this paper intended to address this issue.

Keywords: operational excellence, performance improvement, aviation industry, leadership, people management, continuous improvement

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1. Introduction

It is generally well acknowledged that various businesses, irrespective of industry affiliation, are operating under increasing pressures to improve their productivity and quality. In addition, they also intended to reduce the cost and waste, minimise lead-time, and optimise efficient asset utilisation and flexibility (Duggan, 2012; Jaeger, Matyas & Sihn, 2014; Muazu & Tasmin, 2017). As a result, businesses have realised that it would be challenging for them to excel with only a single business strategy dimension. Therefore, from the strategic perspective, firms are now resorting to OE strategy as the best option to overcome or reduce the rising pressure from their stakeholders and improve performance results with minimal resources. In the pursuit of excellence, the industries are merging their unique constructs from the main performance metrics to pursue OE (Jaeger et al., 2014; Wahab, Ismail & Muhayiddin, 2016). Moreover, thriving companies during the recession were found to have adopted and maintained OE as a strategy. As a result, thriving firms can reduce production costs while improving their operational efficiency (Muazu & Tasmin, 2017; Wahab et al., 2016).

OE is not a new concept, but current conditions create a unique opportunity for the aviation industry, particularly in Sudan, to realize its full promise. External economic factors pressure the industry to be more efficient and cost-effective without ground safety standards. In addition, advances in asset management offer new tools and techniques to leverage airlines' capabilities to streamline operations while increasing service levels.

In Sudan, the central area experiencing challenges is the aviation sector. Currently, Sudan contends with very poor performance levels in aviation activities and facing varying challenges, including aircraft maintenance and overhaul services, aircraft operation services, and even aviation training services, to mention only a few. Instead, business concerns in various aviation industry sectors in the country require an approach to doing business that will ensure their survival during periods of upheavals, decreased operational errors and costs, improved performance, efficiencies, productivity, and customer satisfaction, and finally, business growth; an approach to business such as OE.

In pursuit of gaining potential benefits, organizations in the Sudanese aviation industry have a vested interest in ensuring that their OE implementation initiatives are successful and sustainable. Therefore, they need to understand the underlying critical factors towards the success of OE implementation. These so-called Critical Success Factors (CSFs) need to be identified for decision-making purposes to support OE by organizations in the Sudanese aviation industry.

In this study, the CSFs of OE were provided and dissected to reveal its integrated components and their importance levels, without any of which the achievement of OE would be impossible. These include leadership, people management, continuous improvement, operational strategy, and asset optimization. Furthermore, the impact (outcome) has been presented, and each outcome's weight has been highlighted. Achieving these study objectives will lead to an improved understanding of OE and the factors responsible for achieving OE in the Sudanese aviation industry. In addition, a CSF model will give service providers in the Sudanese aviation industry a decision support basis, consisting of guidelines for the effective implementation and delivery of OE.

The main contribution to the knowledge of this study is creating the framework for the achievement of OE by organizations in the Sudanese aviation industry. The developed framework can be used as a model for the improvement of currently implemented performance improvement initiatives. The purpose of the framework is to guide Sudanese aviation companies through a structured and procedural approach to determine, diagnose, and improve the current performance level and successful implementation of OE among Sudanese companies.

This paper presents the three phases of results using the Delphi hierarchy process (DHP). This section provides an introduction to this article. The second section discusses the success factors for OE based on the literature review. The third section discusses the Delphi expert panel structure, preliminary theoretical framework, and final hierarchy structure, followed by the main steps and timeline. The fourth section discusses the detailed processes and results obtained from the Delphi round 1 study. The fifth section discusses the findings obtained from the second round of the Delphi study. The sixth section discusses the pairwise comparison questionnaire used for the third round of the Delphi technique for ranking the CSFs to sustain the TQM implementation in Sudan. The seventh section

shows the discussion of results obtained from the DHP methodology. Finally, the last section presents the summary of this article.

2. Success Factors for OE

Most industries consider OE as an atmosphere that triggers optimal and continuous performances in all the business facets. (Tasmin & Woods, 2007) stated that OE could be attained through innovation, working process improvement, and managing organisational knowledge, for example, via knowledge leadership, knowledge culture, knowledge technology, knowledge process, and knowledge measurement. Another view by (Russell & Kaplan, 2009) stated that OE is about having the strategy management capability, excellent execution of the plan quickly and economically, and continuous improvement over the long term. OE is also rooted in various business process improvement employed by industries in the last three decades. The improvements include six sigma, lean manufacturing, continuous improvement, business process management, and process excellence. However, (Duggan, 2012) viewed OE as a total isolation approach from lean management and continuous improvement. These approaches only focus on waste elimination or making the organisation better every day. The approach of OE is broader because it sets business growth as a goal and provides a step-by-step approach to achieving the goal in firms.

Different studies have been conducted to determine the CSFs for achieving OE with differing aims and objectives. However, most studies are concerned with critical success factors for a successful OE approach implementation. The literature studies have indicated that several factors that influence OE. The OE of an organisation is linked with organisational efficiency and effectiveness. In the competitive environment, every organisation is under intense pressure to reduce costs without decreasing the output and quality, often termed as efficiency. The state of organisation efficiency is achieved when the organisations become efficient in reducing time wastage, raw materials, unnecessary processing, and energy used in transportation, storing, and operating (Ojha, 2015). Besides, the effectiveness state is obtained when an organisation achieves its long-term goals through increased customer satisfaction and proves its reason for being. Most importantly, OE assures both of these states.

According to Shehadeh, Al-Zu'bi, Abdallah and Maqableh (2016), OE can be attained by linking the organisations' leadership with human resources management (HRM), operation strategy, and organisational commitment. Additionally, they stated that OE is a competitive weapon that should be sought after by different service firms to achieve world-class operational performance. Previous research acknowledged that leadership is the largest single factor responsible for OE. There is always a rapid technological change in the service delivery systems in the service industry. Hence, sector leaders must draw a clear vision to respond to changes while considering the customers' demographic and lifestyle variations. Moreover, leadership is a critical factor in driving OE, but it can work better by aligning with effective organisational commitment.

Ey Oil and Gas Company (2015) stated that OE could be attained by asset reliability and integrity, cost efficiency, supplier and contractors management, integrated planning, and outlines on how processes, people, and systems interact to support the business. Then, it is followed by how they are arranged and prioritised to achieve optimum efficiency (operating model) and health, safety, environment, and quality management. (Wahab et al., 2016) examined the effects of internal environmental factors on the OE of Small and Medium Enterprises (SMEs) manufacturing sector. The internal environmental factors in their study were the resources and capabilities of firms. These factors consist of hard factors (i.e., operation strategy, organisational structure, and process management) and soft factors (i.e., leadership style, human resource practices, and organisational culture).

The literature review suggested the possible relationships between corporate strategy, strategic leadership, and sustainable organisational performance. The existing knowledge of corporate strategy was enhanced by providing an insight into the relationships among corporate strategy, strategic leadership, and sustainable organisational performance (Mukhezakule & Tefera, 2019). OE can only be successfully implemented if the organisation can identify and work with the opportunity. This strategy can be done by applying the most relevant critical factors to achieve success and competitive advantages. The results can help organisations and professionals focus on

continuous improvement methods and lean manufacturing to increase the efficiency of their products or services (Aguilera & Treviño, 2019).

Different sets of CSFs models for OE in the literature are grouped into generic factors and sub-factors. To study these CSFs, the author proposed a comprehensive model of 5 factors and numbers of sub-factors derived from main studies and OE research. Some factors were immersed and were considered in more than one factor for analysis. A detailed analysis of the CSFs for the achievement of OE was carried out, presented, and prioritized based on the frequency analysis. The frequency analysis of the CSFs revealed that the most frequent factor is leadership, followed by human capital and resources and operations strategy. The continuous improvement obtained the fourth rank, followed by asset/facilities reliability and integrity, and the network of suppliers obtained the minor frequency.

3. Conceptual Model and Operationalisation using Delphi Expert Panels and DHP

The Delphi technique is an established research methodology well suited for incomplete knowledge about a problem or phenomenon. It is well suited for doctoral and master's research (Adler & Ziglio, 1996; Skulmoski, Hartman & Krahn, 2007). It is based on the structuring of group communication so that the process is effective, allowing individuals to deal with a problem (Amos & Pearse, 2008; Turoff & Linstone, 2002). The method allows consensus to be reached amongst a panel of experts on a specific issue or topic by using multi-staged questionnaires (Keeney, Hasson & McKenna, 2017).

According to Bourgeois, Pugmire, Stevenson, Swanson and Swanson (2006), the uniqueness of Delphi lies in its reliability, given the variableness of human opinion, and in its ability to be administered remotely and without direct participant interaction. Using this technique offers several advantages, making it a critical research methodology for OE research. It utilizes experts in the field and brings together the collective wisdom of expert panellists in a cost-effective manner.

The DHP used in this study consists of three rounds of the survey conducted on ten industrial and academic experts. The experts were practitioners and academics with more than ten years of working and researching experiences in the Sudanese aviation industry, as listed in Table 1. The results obtained from each round of study were analysed, while the feedback obtained from the respondents were examined to understand their opinions regarding the studied topics. The analysis started by exploring the results from rounds 1 and 2 of the Delphi techniques. Then, it was followed by analysing the data obtained from the selected experts from Sudanese aviation organisations and obtaining consensus from the panel. The ranking of CSFs essential for the OE achievement in the Sudanese aviation industry from the analytic hierarchy process (AHP) was conducted during round 3 of the Delphi technique by using the pairwise comparison questionnaire.

No.	Names	Positions	Experiences	Categories
1	H.A.A.	General Manager of Green Flag Aviation Company Ltd	17 years	Industrialist
2	M.M.A.	Operations Manager at Green Flag Aviation Company Ltd	10 years	Industrialist
3	A.E.X.	General Manager of SAFAT Aircraft Manufacturing Centre	15 years	Industrialist
4	M.S.E.	Quality Manager at SAFAT Aircraft Manufacturing Complex	16 years	Industrialist/ Academic
5	Y.M.Y.	General Manager of Crop Protection Services (C.P.S.) Company	14 years	Industrialist
6	A.A.M.	General Manager of SAFAT Training Complex	15 years	Industrialist/ Academic
7	A.A.A.	Quality Manager at SAFAT Aircraft M.R.O. Complex	17 years	Industrialist
8	A.M.O.	General Manager of SAFAT Aircraft Maintenance Centre	12 years	Industrialist
9	O.S.M.	Operations Manager at Tarco Aviation Company Ltd	43 years	Industrialist
10	E.H.A.	Engineering Manager at Tarco Aviation Company Ltd	13 years	Industrialist

Table 1. Expert Panel Members

Round 1 of Delphi's study included the formation and selection of expert panels. The first round was conducted in December 2019 until July 2020, while the second round was conducted in August 2020 until October 2020. The third round was conducted at the beginning of November 2020 and completed in December 2020. The ten selected experts participated in all the rounds of study through emails or interview sessions.

3.1. Delphi Round 1

In the first round, the expert panels were asked to validate some general factors adapted from the preliminary theoretical framework of CSFs for OE. The framework was derived from the literature review. Then, the semi structured interview was conducted on the selected experts to collect data for the round 1 DHP method. All the expert panel members participated in this round. A set of questionnaires for round 1 was sent via email to all the experts to ensure they were prepared beforehand. The first round of the Delphi method consists of three parts. Part 1 inquired about the participants' general information, such as name, contact details, current position in their company, current work experience, and previous employment details. Part 2 inquired about the participants' organisational information, such as the company's name, type of ownership, approximate number of employees, and job scope. At the end of the second part, the experts were asked to identify the existing implementation of quality tools and techniques among the Sudanese companies.

In the last section, the expert panels were asked to determine their agreement of the identified CSFs and subfactors under each CSFs. Then, the factor was adjusted by the experts through deleting, moving, or modifying. At the end of Part 3, the expert panels were asked to write any comments regarding the proposed CSFs model. Additionally, they were requested to list any additional benefits of implementing the OE philosophy, especially in the Sudanese aviation industry, and the barriers that hinder the successful implementation of these factors.

According to the panel members, there is a lack of tools for the OE implementation. It was observed that most of the Sudanese aviation companies were not implementing statistical techniques and improvement methodologies, such as kaizen and lean six sigma. In addition, the companies that are certified with ISO 9001 did not continuously improve their in-place methodologies. As validated by the panel experts, most of the commonly adopted Sudanese aviation companies' tools include simple quality tools, corrective actions, and preventive actions. Other tools, such as brainstorming, SWOT analysis, and seven quality tools, are used in the Sudanese aviation companies, as per the expert panels' feedback. The results also indicated a lack of advanced OE frameworks and models, such as the Shingo model for OE, and the lack of implementation of these frameworks due to psychological barriers.

The expert panels revealed the five primary key barriers, namely lack of understanding of the potential benefits of OE implementation, lack of knowledge or understanding about the different OE models and approaches, lack of linking between improvement projects and OE results, psychological inertia towards the advanced OE techniques, and lack of structured and straightforward approach for OE in the aviation industry. Other vital barriers that affect the OE philosophy implementation in the Sudanese aviation industry were lack of clear assignment of roles and responsibility towards OE and lack of top management commitment, preliminary measurement analysis, and improvement system. In addition, the expert panel members specified that the most important barriers that affected the OE achievement in the Sudanese aviation industry were poor employee perception and organisational culture and lack of resources. Table 2 shows the analysis of critical barriers derived from expert panels' opinions.

The last section of the first round Delphi method investigated the opinions of panel experts, especially on the hierarchy model of CSFs for achieving OE in the Sudanese aviation industry. First, the proposed critical factors were reviewed and presented in a graphical hierarchical form. Figure 1 presents the initial AHP structure for achieving OE in the Sudanese aviation industry. Next, the panels were asked to determine their agreement levels on the identified CSFs and subfactors under each CSFs. Suppose they disagree with the CSFs or subfactors under each CSFs. In that case, they can make adjustments by deleting, moving, or modifying the CSFs and subfactors by writing any comments regarding the proposed CSFs model.

No.	Key barriers	The number of experts
1	Lack of understanding of potential benefits of OE implementation	8
2	Lack of knowledge/understanding about different OE models and approaches	10
3	Lack of linking between improvement projects and OE results	6
4	Psychological inertia towards the advanced OE techniques	7
5	Lack of structured and straightforward approach for OE in the aviation industry	9
6	Lack of the exact assignment of roles and responsibility towards OE	10
7	Lack of top management commitment	5
8	Low measurement, analysis, and improvement system	9
9	Poor employee perception and organisational culture	6
10	Lack of resources	4

Table 2. The Analysis of Crucial Barriers Affecting the Achievement of OE in the Sudanese Aviation Industry

All the members from the expert panel responded to the Delphi round 1 study. Generally, they agreed with the five CSFs categories for achieving OE in the Sudanese aviation industry. However, the selected experts provided suggestions concerning level two and level three of the study. As a result, changes were made, and the structure of CSFs was revised according to their suggestions, as shown in Figure 2.

Level Two: Experts made adjustments to the proposed AHP model by replacing human resources with people management, continuous improvement with improvement, and operation strategy with operational planning at level two.

Leadership: The act as a role model subfactor was edited to act as a role model and inspire other people. A clear vision towards technological advancement was merged with develop vision, values, and ethics subfactor. Additionally, managing information and knowledge, accountable for achieving effective and efficient results, and leading and managing others effectively and efficiently were placed under the managing organisation performance. Moreover, the subfactors of establish internal and external awareness and support people to achieve their plans and objectives were deleted. Finally, the leadership commitment subfactor was renamed as commitment to OE principles.

People Management: In level two, the human resources subfactor was replaced with people management. While in the third level, the subfactors under people management factor, such as promoting fairness and equality and developing organisational culture were moved to the leadership category and placed under develop vision, values, and ethics subfactor. Furthermore, establish channels for employees' feedback subfactor was placed under encourage employees' involvement and empowerment. Additionally, employees' training and awareness programmes subfactor was renamed as development of people's skills and competencies, while organisational commitment was renamed as encourage organisational commitment and loyalty.

Improvement: According to the Delphi panellists, the subfactor of setting aims and objectives for performance improvement was replaced by setting targets and objectives for performance improvement in level three. Moreover, the subfactors of process management and process standardisation were renamed as establishing process management approaches and establishing process standardisation approaches under the same improvement dimension. Additionally, the subfactor of performance measurement and reporting was placed under developing performance measurement and reporting process.

Operational Planning: In level two, operation strategy was replaced with operational planning. For the subfactors under operational planning, establishment of targets and objectives was edited to establish operation targets and objectives. Under the same dimension, the subfactors of formulation of operation strategy and review of strategy and evaluate results were renamed as formulation of operation plans and review of operation plans and evaluate results. Furthermore, the subfactors of communicate operation strategy with relevant interested parties and

deployment of operation strategy were edited as communicate operation plans with relevant interested parties and stakeholders and deployment of operation plans in a structured manner.

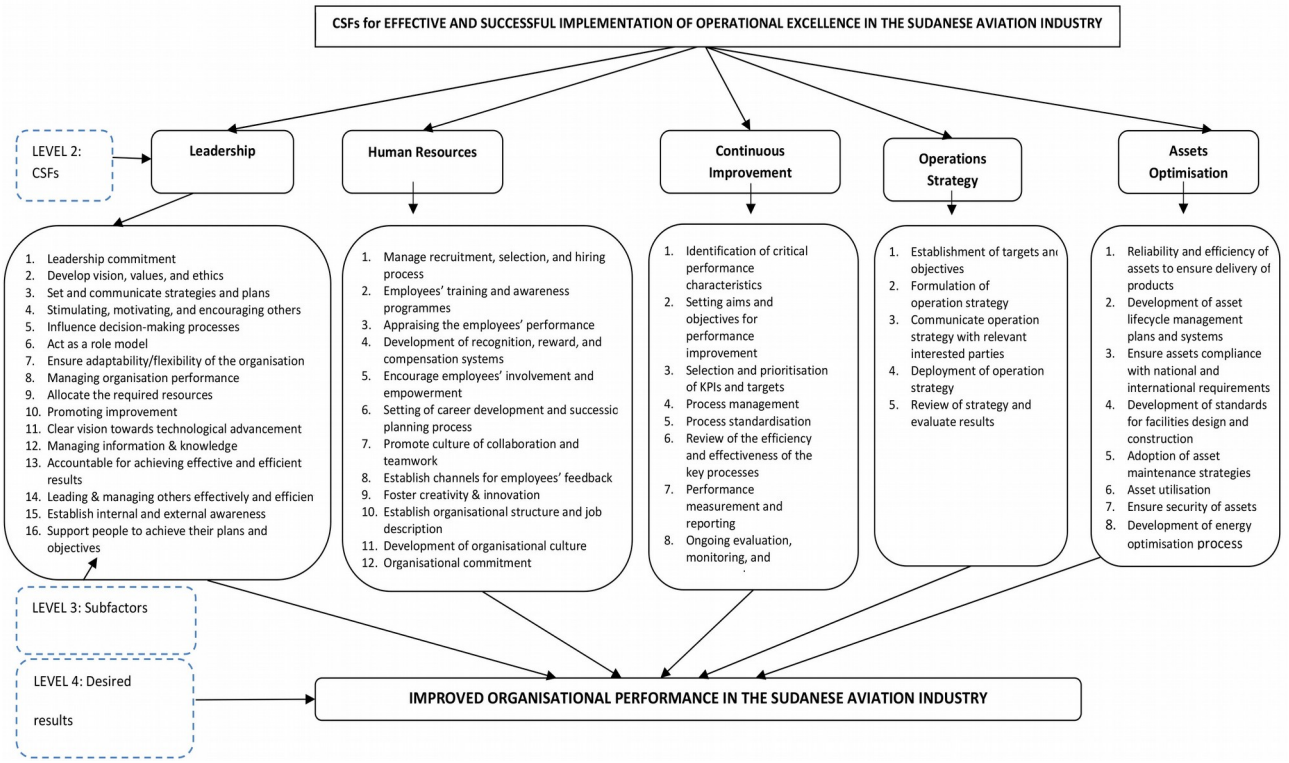

Figure 1. The Initial AHP Structure for OE in the Sudanese Aviation

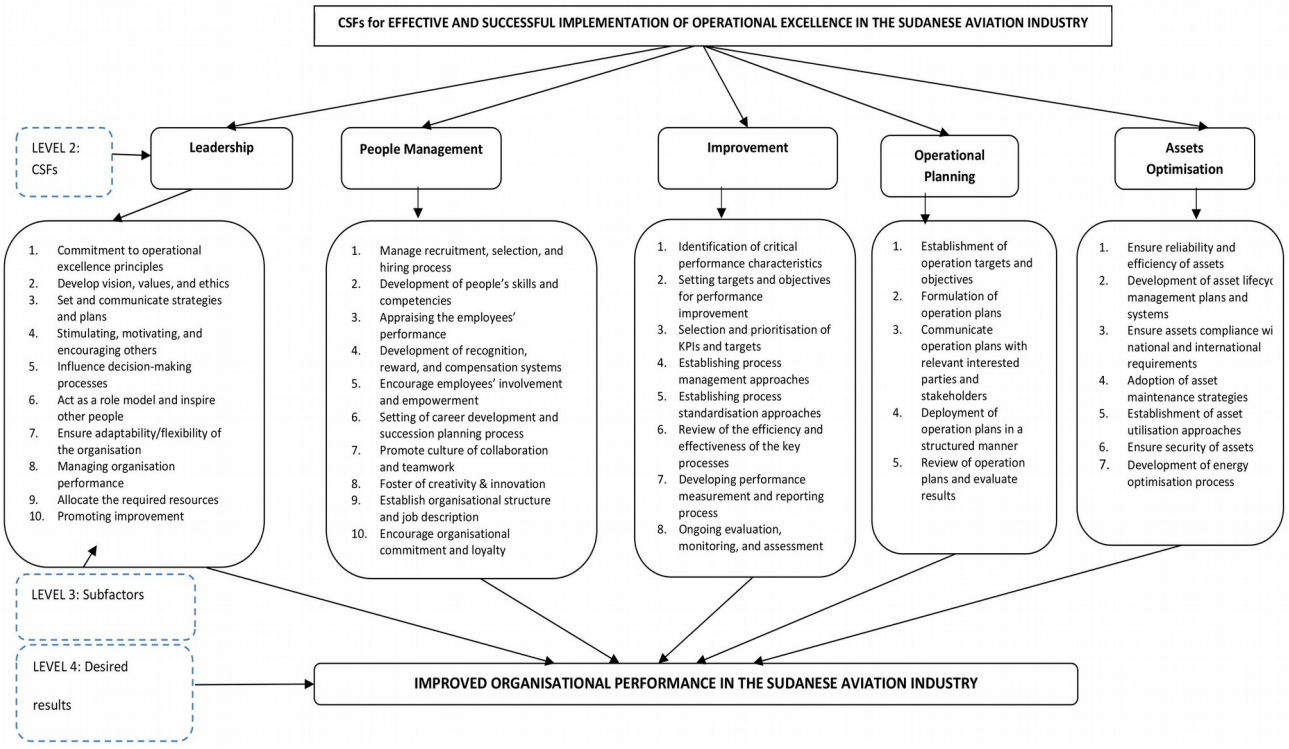

Figure 2. Proposed AHP Model for OE in the Sudanese Aviation

Assets Optimisation: Reliability and efficiency of assets to ensure the delivery of products or services subfactor was edited to ensure the reliability and efficiency of the assets subfactor. Additionally, the subfactors of ensure asset management capabilities and ensure the effective use of technology were placed under the development of asset lifecycle management plans and systems. Moreover, the subfactor of development of standards for facilities design and construction was removed due to its irrelevancy to this study. Finally, asset utilisation subfactor was restated as establishment of asset utilisation approaches.

Thus, the first round of the Delphi study was developing the hierarchy structure of the CSFs model into the newly proposed CSFs model for achieving OE in the Sudanese aviation industry. Academical and industrial experts agreed that this is a robust framework. However, there were some suggestions, such as promoting the assets' improvement and optimisation, customise the advanced tools for the Sudanese companies, and designing a simple approach for continuous improvement from the participants to reduce the physiological barriers towards advanced OE frameworks and models. They also suggested to link OE with CSFs according to strategic directions. Additionally, the experts suggested considering the organisation and its context due to some hidden factors from the internal and external environment that may affect the OE projects and initiatives. Table 3 shows the fundamental changes made by the expert panels in reviewing the initial AHP for CSFs to achieve the OE in the Sudanese aviation industry.

Factors			Subfactors		Experts contributed to the Change
			Before	After	
1	Before	Leadership	Leadership commitment	Commitment to OE principles	All
			Develop vision, values, and ethics	Develop vision, values, and ethics	
			Set and communicate strategies and plans	Set and communicate strategies and plans	
			Stimulating, motivating, and encouraging others	Stimulating, motivating, and encouraging others	
			Influence decision-making processes	Influence decision-making processes	
			Act as a role model	Act as a role model and inspire other people	
			Ensure adaptability/flexibility of the organisation	Ensure adaptability/flexibility of the organisation	
			Managing organisation performance	Managing organisation performance	
	After	Leadership	Allocate the required resources	Allocate the required resources	
			Promoting improvement	Promoting improvement	
			Clear vision towards technological advancement	Develop vision, values, and ethics	
			Managing information and knowledge	Managing organisation performance	
			Accountable for achieving effective and efficient results	Managing organisation performance	
			Leading and managing others effectively and efficiently	Managing organisation performance	
			Establish internal and external awareness	-	
			Support people to achieve their plans and objectives	-	

Factors			Subfactors		Experts contributed to the Change
			Before	After	
2	Before	Human Resources	Manage recruitment, selection, and hiring process	Manage recruitment, selection, and hiring process	M.M.A., Y.M.Y., A.A.M., A.A.A., and O.S.M.
			Employees' training and awareness programmes	Development of people's skills and competencies	
			Appraising the employees' performance	Appraising the employees' performance	
			Development of recognition, reward, and compensation systems	Development of recognition, reward, and compensation systems	
			Encourage employees' involvement and empowerment	Encourage employees' involvement and empowerment	
			Setting of career development and succession planning process	Setting of career development and succession planning process	
	After	People Management	Promote a culture of collaboration and teamwork	Promote a culture of collaboration and teamwork	
			Establish channels for employees' feedback	Encourage employees' involvement and empowerment	
			Foster of creativity and innovation	Foster of creativity and innovation	
			Establish organisational structure and job description	Establish organisational structure and job description	
			Development of organisational culture	-	
			Organisational commitment	Encourage organisational commitment and loyalty	
			Promote fairness and equality	-	
3	Before	Continuous Improvement	Identification of critical performance characteristics	Identification of critical performance characteristics	H.A.A., M.S.E., A.A.M., A.M.O., and E.H.A.
			Setting aims and objectives for performance improvement	Setting targets and objectives for performance improvement	
			Selection and prioritisation of KPIs and targets	Selection and prioritisation of KPIs and targets	
			Process management	Establishing process management approaches	
	After	Improvement	Process standardisation	Establishing process standardisation approaches	
			Review of the efficiency and effectiveness of the critical processes	Review of the efficiency and effectiveness of the critical processes	
			Performance measurement and reporting	Developing performance measurement and reporting process	
			Ongoing evaluation, monitoring, and assessment	Ongoing evaluation, monitoring, and assessment	

Factors			Subfactors		Experts contributed to the Change
			Before	After	
4	Before	Operations Strategy	Establishment of targets and objectives	Establishment of operation targets and objectives	H.A.A., M.M.A., A.A.M., Y.M.Y., A.A.A., and M.S.E.
			Formulation of operation strategy	Formulation of operation plans	
			Communicate operation strategy with relevant interested parties	Communicate operation plans with relevant interested parties and stakeholders	
	After	Operational Planning	Deployment of operation strategy	Deployment of operation plans in a structured manner	
			Review of the strategy and evaluate results	Review of the operation plans and evaluate results	
5	Before	Assets Optimisation	Reliability and efficiency of assets to ensure delivery of products	Ensure reliability and efficiency of assets	All
			Development of asset lifecycle management plans and systems	Development of asset lifecycle management plans and systems	
			Ensure assets compliance with national and international requirements	Ensure assets compliance with national and international requirements	
			Development of standards for facilities design and construction	-	
			Adoption of asset maintenance strategies	Adoption of asset maintenance strategies	
	After	Assets Optimisation	Asset utilisation	Establishment of asset utilisation approaches	
			Ensure security of assets	Ensure security of assets	
			Development of energy optimisation process	Development of energy optimisation process	
			Ensure effective use of technology	Development of asset lifecycle management plans and systems	
			Ensure availability of asset management capabilities	Development of asset lifecycle management plans and systems	

Table 3. Key Changes for Initial AHP Structure

3.2. Delphi Round 2

The main objective of conducting the second round of the Delphi technique was to obtain the experts' consensus according to the CSFs' final AHP model for effective implementation and continuous improvement of OE principles. After the adjustments and changes were made to the model, the expert panels reviewed the revised AHP model through emails and interviews (as shown in Figure 2). All the experts who participated in this round agreed with the revised hierarchy model that stated the CSFs for achieving OE in the Sudanese aviation industry. Furthermore, the experts strongly agreed that the CSFs for achieving OE derived from the literature review and Delphi technique rounds were consistent for the application in the Sudanese aviation industry. Therefore, the revised model is appropriate for the third round of the Delphi technique.

3.3. Delphi Round 3

In the last round of the Delphi technique, the experts were asked to determine the relative scales of critical factors and subfactors that affected the OE achievement in the Sudanese aviation industry in a pairwise fashion. The pairwise relationship was constructed by referring to the approach introduced by (Saaty, 1980) and used the point scale and score techniques. All the members from the expert panel participated in this round. They assessed the pairwise comparison amongst the five CSFs and 40 subfactors, similar to the outputs achieved from rounds one and two of the Delphi studies. Lastly, a series of judgment matrices for the critical factors and subfactors were obtained. Round three of the Delhi study was conducted based on the calculated importance weight or relative weights to critical factors and subfactors. A pairwise comparison matrix was developed to calculate the "weights" involved in the relative significance among the criteria in the second hierarchy level. Microsoft Excel was used to determine the ranking of critical factors and subfactors to obtain the local and global priority weights. The local priority weight is relative to the parent elements, whereas the global priority weight is relative to the goal.

The local weight is the priority of an element and is related to the primary element. Hence, it is usually the first to be calculated. Meanwhile, the global weight of each element that is related to achieving the OE in the Sudanese aviation industry was calculated by multiplying the local weight of an element by the weight of its primary element. Tables 4 and 5 show the normalised judgment and ranking local weights from the expert panels for the criteria and subcriteria. After that, the consistency ratio (CR) was calculated to measure the consistency between the expert panels' judgments. The CR indicates how consistently the experts were responding, as compared to the criteria. Saaty (1990) developed the AHP and stated that CR with a value of 0.10 or less is considered acceptable. Table 4 shows that the overall pairwise comparisons were consistent (CR=0.059) and demonstrated the judgments' overall consistency falls within the suggested ratio of 0.10 (Saaty, 1990).

Achievement of the OE in the Sudanese Aviation Industry (CR=0.059)	Weights	Absolute Errors	Ranking
Leadership	0.402	0.146	1
People Management	0.303	0.121	2
Improvement	0.072	0.08	5
Operational Planning	0.144	0.065	3
Asset Optimisation	0.079	0.032	4

Table 4. Normalised Local Weights of Judgment and Ranking for Criteria

Table 5 summarises the priorities of criteria for the enabling factors and subfactors. The geometric mean was used to synthesise and assess each evaluator. The results from the geometric mean of evaluators were combined in the judgment matrixes of pairwise comparison. Figure 3 shows the summary of critical factors affecting the OE's achievement, which was obtained based on the judgment matrices and evaluation results. Then, the results demonstrated that the CR for these matrices falls under 0.10, indicating that the results were within the acceptable level.

The following section discusses the relative weights of each criterion from both categories and subcategories based on the priorities calculated. Table 6 shows the ranking of the critical factors based on the local weights.

Level Two: For the main categories of CSFs, leadership (0.402) was observed to be the most important factor, followed by people management (0.303), operational planning (0.144), asset optimisation (0.079), and improvement (0.072), based on the results obtained using the calculation of the global weights. The results showed that the three most critical subfactors affecting the Sudanese aviation industry's OE were Leadership, people management, and operational planning. It was also observed that the subfactors of asset optimisation (0.079) and improvement (0.072) obtained similar weights; hence, they were placed at the fourth and fifth rank, respectively. However, it was evident that the improvement (0.072) subfactor was the least influential factor. In conclusion, these findings indicated the agreement of evaluators that there was an insignificant difference within the importance of CSF subfactors.

Level 2	Weights	Level 3	Weights	Ranking
Leadership	0.402	• Commitment to OE principles	0.124	3
		• Develop vision, values, and ethics	0.132	2
		• Set and communicate strategies and plans	0.103	4
		• Stimulating, motivating, and encouraging others	0.068	9
		• Influence decision-making processes	0.161	1
		• Act as a role model and inspire other people	0.085	8
		• Ensure adaptability/flexibility of the organisation	0.091	6
		• Managing organisation performance	0.101	5
		• Allocate the required resources	0.088	7
		• Promoting improvement	0.047	10
People Management	0.303	• Manage recruitment, selection, and hiring process	0.136	2
		• Development of people's skills and competencies	0.082	6
		• Appraising the employees' performance	0.064	9
		• Development of recognition, reward, and compensation systems	0.068	7
		• Encourage employees' involvement and empowerment	0.089	5
		• Setting of career development and succession planning process	0.107	3
		• Promote a culture of collaboration and teamwork	0.102	4
		• Foster creativity and innovation	0.031	10
		• Establish organisational structure and job description	0.258	1
		• Encourage organisational commitment and loyalty	0.064	8
Improvement	0.072	• Identification of critical performance characteristics	0.31	1
		• Setting targets and objectives for performance improvement	0.21	2
		• Selection and prioritisation of KPIs and targets	0.149	3
		• Establishing process management approaches	0.097	4
		• Establishing process standardisation approaches	0.064	5
		• Review of the efficiency and effectiveness of the critical processes	0.055	8
		• Developing of performance measurement and reporting process	0.056	7
		• Ongoing evaluation, monitoring, and assessment	0.059	6
Operational Planning	0.144	• Establishment of operation targets and objectives	0.514	1
		• Formulation of operation plans	0.245	2
		• Communicate operation plans with relevant interested parties and stakeholders	0.125	3
		• Deployment of operation plans in a structured manner	0.072	4
		• Review of the operation plans and evaluate results	0.044	5
Asset Optimisation	0.079	• Ensure reliability and efficiency of assets	0.125	3
		• Development of asset lifecycle management plans and systems	0.096	4
		• Ensure asset compliance with national and international requirements	0.449	1
		• Adoption of asset maintenance strategies	0.08	5
		• Establishment of asset utilisation approaches	0.146	2
		• Ensure security of assets	0.061	6
		• Development of energy optimisation process	0.044	7

Table 5. Normalised Local Weights of Judgment and Ranking for Enabling Factors and Subfactors Based on the Outcomes of Expert Panels

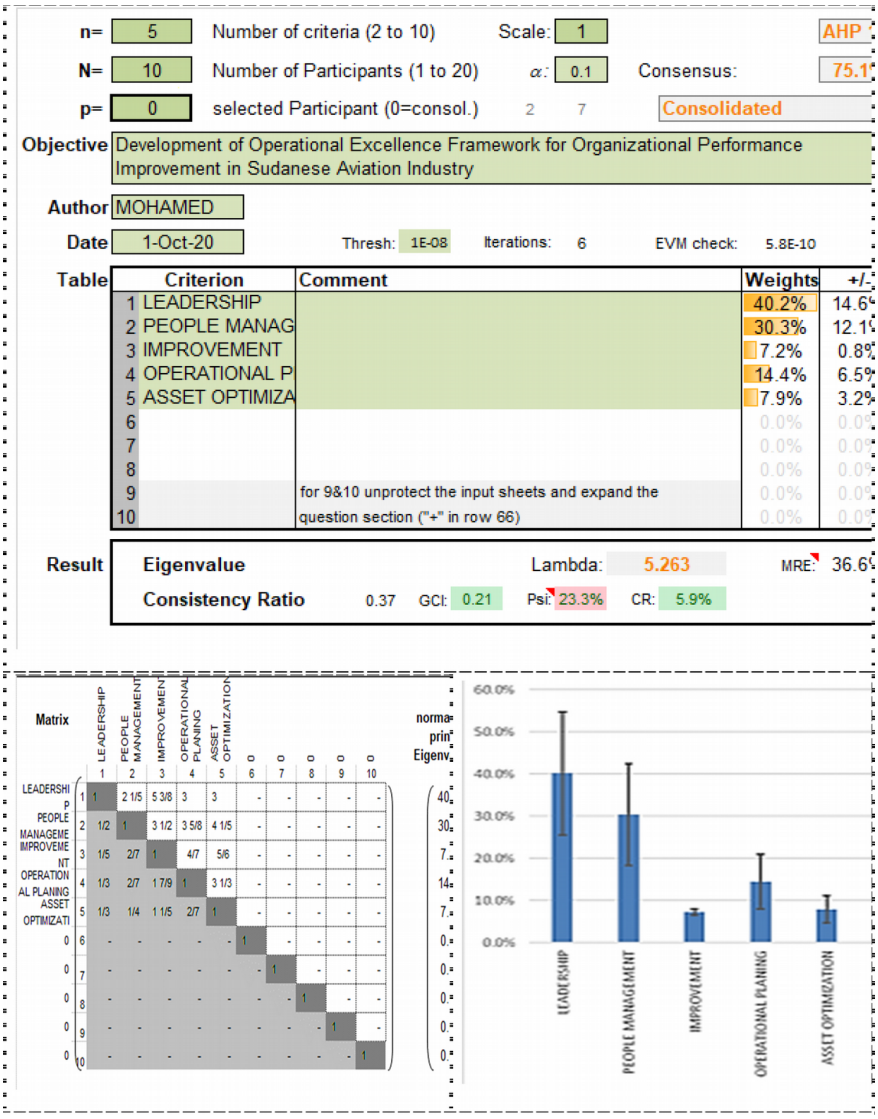

Figure 3. Level 2–Summary of Critical Factors Affecting the Achievement of the OE in the Sudanese Aviation Industry

Criteria	Weights	Absolute Errors	Ranking
Leadership	(0.402)	0.146	1
People Management	(0.303)	0.121	2
Operational Planning	(0.144)	0.08	3
Asset Optimisation	(0.079)	0.065	4
Improvement	(0.072)	0.032	5

Table 6. The Ranking of the Critical Factors Based on Local Weights

Leadership: The item of influence decision-making processes was the most important criterion. Then, the next most important criterion for leadership was develop vision, values, and ethics, followed by commitment to OE principles. Next, the importance ranking continued with set and communicate strategies and plans, managing organisation performance, ensure adaptability/flexibility of the organisation, and allocate the required resources. After that, the subsequent importance ranking for leadership were acting as a role model, inspiring other people, and stimulating, motivating, and encouraging others. Finally, the promoting improvement criterion was the least important subfactor.

People Management: For people management, establishment of organisational structure and job description, management of recruitment, selection and hiring process, and career development and succession planning process were the three most important criteria. The next most important criteria were promote collaboration and teamwork, encourage employee involvement and empowerment, and develop people's skills and competencies. The ranking of subfactors continued with development of recognition, reward, and compensation systems. The encouragement of organisational commitment and loyalty and appraisal of the employees' performance were considered the next highest important rating. The subfactors of encouragement of organisational commitment and loyalty (0.064) and appraisal of the employees' performance (0.064) obtained the same weights; thus, they were placed at the eighth and ninth rank, respectively. Finally, the foster of creativity and innovation was the least important subfactor. The findings demonstrated a disagreement between the evaluators on the importance ranking for the subfactors of people management.

Operational Planning: In the operational planning section, establishment of operation targets and objectives was the most important subfactor. It was followed by formulation of operation plans and communicating operation plans with relevant interested parties and stakeholders with a similar level of importance. The relative importance of these two criteria for operational planning was similar. The next was deployment of operation plans in a structured manner, whereas the subfactor of review of operation plans and evaluate results was the least important.

Asset Optimisation: For this category, assets compliance with national and international requirements and establishment of asset utilisation approaches were the two most significant subcriteria for asset optimisation. The subsequent essential criteria were reliability and efficiency of assets, development of asset lifecycle management plans and systems, and adoption of asset maintenance strategies, and reward and compensation systems. Finally, the subfactor of the security of assets and the development of energy optimisation process received the least important rating.

Improvement: For the improvement dimension, the major subcriteria was identification of critical performance characteristics. The next most important criteria were setting targets and objectives for performance improvement and selecting and prioritising KPIs and targets. The subfactors of establishment of process management approaches and establishment of process standardisation approaches were the next two criteria. Then, the list continued with ongoing evaluation, monitoring, and assessment that received the next highest important rating. The next subfactor was developing the performance measurement and reporting process that received a slightly higher rating than review of the critical processes efficiency and effectiveness.

Table 8 shows the calculation results of global weights for the 40 subfactors. The findings showed that the ten most important subfactors were (1) establishing organisational structure and job description, (2) establishing operation targets and objectives, (3) influencing decision-making processes, (4) development of vision, values, and ethics, (5) commitment to OE principles, (6) setting and communicating strategies and plans, (7) management of recruitment, selection, and hiring process, (8) managing organisation performance, (9) ensure adaptability or flexibility of the organisation, and (10) ensure asset compliance with national and international requirements.

Criteria	Weights
Leadership (CR=0.037)	
1. Influence decision-making processes	0.161
2. Develop vision, values, and ethics	0.132
3. Commitment to OE principles	0.124
4. Set and communicate strategies and plans	0.103
5. Managing organisation performance	0.101
6. Ensure adaptability/flexibility of the organisation	0.091
7. Allocate the required resources	0.088

Criteria	Weights
8. Act as a role model and inspire other people	0.085
9. Stimulating, motivating, and encouraging others	0.068
10. Promoting improvement	0.047
People Management (CR=0.072)	
1. Establish organisational structure and job description	0.258
2. Manage recruitment, selection, and hiring process	0.136
3. Setting of career development and succession planning process	0.107
4. Promote a culture of collaboration and teamwork	0.102
5. Encourage employees' involvement and empowerment	0.089
6. Development of people's skills and competencies	0.082
7. Development of recognition, reward, and compensation systems	0.068
8. Encourage organisational commitment and loyalty	0.064
9. Appraising the employees' performance	0.064
10. Foster creativity and innovation	0.031
Operational Planning (CR=0.217)	
1. Establishment of operation targets and objectives	0.514
2. Formulation of operation plans	0.245
3. Communicate operation plans with relevant interested parties and stakeholders	0.125
4. Deployment of operation plans in a structured manner	0.072
5. Review of operation plans and evaluate results	0.044
Asset Optimisation (CR=0.083)	
1. Ensure asset compliance with national and international requirements	0.449
2. Establishment of asset utilisation approaches	0.146
3. Ensure reliability and efficiency of assets	0.125
4. Development of asset lifecycle management plans and systems	0.096
5. Adoption of asset maintenance strategies	0.08
6. Ensure security of assets	0.061
7. Development of energy optimisation process	0.044
Improvement (CR=0.076)	
1. Identification of critical performance characteristics	0.31
2. Setting targets and objectives for performance improvement	0.21
3. Selection and prioritisation of KPIs and targets	0.149
4. Establishing process management approaches	0.097
5. Establishing process standardisation approaches	0.064
6. Ongoing evaluation, monitoring, and assessment	0.059
7. Developing performance measurement and reporting process	0.056
8. Review of the efficiency and effectiveness of the key processes	0.055

Table 7. Summary of Ranking for the 40 Subfactors Based on Local Weights

Subfactors	Global Weights	Ranking
Establishment of organisational structure and job description	0.078	1
Establishment of operation targets and objectives	0.074	2
Influence decision-making processes	0.065	3
Develop vision, values, and ethics	0.053	4
Commitment to OE principles	0.050	5
Set and communicate strategies and plans	0.041	6
Manage recruitment, selection, and hiring process	0.041	7
Managing organisation performance	0.041	8
Ensure adaptability/flexibility of the organisation	0.037	9
Ensure asset compliance with national and international requirements	0.035	10
Allocate the required resources	0.035	11
Formulation of operation plans	0.035	12
Act as a role model and inspire other people	0.034	13
Setting of career development and succession planning process	0.032	14
Promote a culture of collaboration and teamwork	0.031	15
Stimulating, motivating, and encouraging others	0.027	16
Encourage employees' involvement and empowerment	0.027	17
Development of people's skills and competencies	0.025	18
Identification of critical performance characteristics	0.022	19
Development of recognition, reward, and compensation systems	0.021	20
Encourage organisational commitment and loyalty	0.019	21
Appraising the employees' performance	0.019	22
Promoting improvement	0.019	23
Communicate operation plans with relevant interested parties and stakeholders	0.018	24
Setting targets and objectives for performance improvement	0.015	25
Establishment of asset utilisation approaches	0.012	26
Selection and prioritisation of KPIs and targets	0.011	27
Deployment of operation plans in a structured manner	0.010	28
Ensure reliability and efficiency of assets	0.010	29
Foster creativity and innovation	0.009	30
Development of asset lifecycle management plans and systems	0.008	31
Establishing process management approaches	0.007	32
Review of the operation plans and evaluate results	0.006	33
Adoption of asset maintenance strategies	0.006	34
Ensure security of assets	0.005	35
Establishing process standardisation approaches	0.005	36
Ongoing evaluation, monitoring, and assessment	0.004	37
Developing performance measurement and reporting process	0.004	38
Review of the efficiency and effectiveness of the key processes	0.004	39
Development of energy optimisation process	0.003	40

Table 8. The Ranking of the Subfactors Based on the Global Weights

4. Discussions

The Delphi process used in this study was for three rounds. The primary purpose of the first round is to determine the CSFs for the achievement of the OE by organizations in the Sudanese aviation industry. In this round, the panel of experts was asked to validate some general factors of the preliminary theoretical framework of CSFs for OE derived from the literature review. The second phase was to conduct round two of the Delphi technique. The primary outcome from this phase is to come up with the final hierarchy model of CSFs for the achievement of OE by organizations in the Sudanese aviation industry. Table 9 shows the main activities and elements of Delphi rounds 1 and 2.

Activities/elements	Delphi technique Round 1	Delphi technique Round 2
Experts Selection	Sample selection of experts	Same as Delphi round 1
Questionnaire	Open-end and closed-end questions for Delphi round 1 questionnaire were designed to determine CSFs and validate CSFs derived from the literature review. The primary outcome from Delphi round one is to obtain criteria for the achievement of OE by organizations in the Sudanese aviation industry	Open-end and closed-end questions to get consensus related to the identified CSFs
Data collection	Survey	Survey
Analysis of response to the questionnaire	Sorted criteria to the establish CSFs	Development of the critical factors structure
Results	CSFs hierarchy	Established CSF framework

Table 9. The main activities and elements of Delphi round 1 and 2

The Third Phase of the Delphi technique was the Analytic Hierarchy Process (AHP) application. This phase involved deploying the AHP approach in Delphi round 3 to rank the critical success factors for achieving OE by organizations in the Sudanese aviation industry. A set of AHP related questionnaires was used during interview activities to construct the AHP model. The primary outcome from Delphi Round 3 is to calculate the importance weight to criteria and sub-criteria of the proposed OE framework elements.

After the validation through the DHP methodology, comprehensive CSFs criteria for achieving OE in the Sudanese aviation industry were collected and structured into an AHP criteria model, specifically in a judgment hierarchy based on the feedback from industrial and academic Sudanese experts. The top level of the proposed hierarchical structure was to improve the organisation's organisational performance in the Sudanese aviation industry and provide an effective and successful implementation. There were five main factors: 1) leadership, 2) people management, 3) operational planning, 4) assets optimisation, and 5) improvement in the next level. Based on the AHP, the relative priorities of factors, subfactors, and criteria were determined using pairwise comparison. In addition, the third level analysis considered 40 subfactors for the OE achievement in the Sudanese aviation industry.

Based on all the feedback received from the experts, the leadership factor was the most critical factor in achieving improved organisational performance and goals, followed by people management. Hence, these two factors were considered the primary elements of the proposed framework for achieving OE for the Sudanese aviation industry. Based on the results, leaders play crucial roles in the OE achievement in the Sudanese aviation industry. The leaders should be committed to the OE principles and demonstrate the ability to influence the decision-making processes and develop the organisational vision, values, and ethics. This statement supported the new amendment proposed by the EFQM excellence model (EFQM, 2012) and Shingo model for the OE view. Next, the operational planning factor received the third ranking. Therefore, this factor can be considered vital for achieving OE in the Sudanese aviation industry. The results showed that the subfactors of establishment of operation targets and objectives and formulation of operation plans obtained the highest ranking in the operational planning category. This result implied that establishing operation targets and plans should be considered significant to sustain the TQM implementation in Sudan. OE Consulting Group (2016) stated that OE organisations follow a well-defined strategy

and operational planning and deployment process that ensures the collaboration and alignment among the different organisational parts besides effectively linking strategic and operational objectives, initiatives, and execution.

The results revealed that asset optimisation obtained nearly the same weight as improvement and was placed at the fourth rank. Hence, the evaluators agreed with the insignificant difference between the importance of CSF with others. However, the overall evaluation of global weight (as shown in Table 8) indicated that the most critical subfactor in assets optimisation was asset compliance with national and international requirements. This result indicated the importance of compliance with national and international civil aviation regulations. The aviation industry is highly regulated under various agreements and regulations due to its instinctive safety risks associated with aircraft operations. These results were proven and supported by the EFQM excellence model (EFQM, 2012) and Chevron corporation OE management system (Chevron Corporation, 2010). Even though the subfactor of selection and prioritisation of KPIs and targets obtained a higher ranking than establishment of asset utilisation approaches, the overall evaluation of global weight (as shown in Table 8) indicated that establishment of asset utilisation approaches (0.012) obtained higher weight compared to selection and prioritisation of KPIs and targets (0.011). This result confirmed the importance of asset optimisation in the achievement of improved organisational performance.

The subfactor of improvement achieved the least ranking. Furthermore, the subfactors of review of the efficiency and effectiveness of the critical processes and development of energy optimisation process obtained the lowest ranking based on the global weight calculation. These results indicated that the performance measurement was more crucial than reviewing the key efficiency and effectiveness processes. Additionally, the asset's energy consumption had little or no effect on the OE in the Sudanese aviation industry. Based on the results, it can be concluded that establishment of organisational structure and job description, establishment of operation targets and objectives, influencing of decision-making processes, development of vision, values, and ethics, and commitment to OE principles play important roles in improving the Sudanese aviation organisational performances. These findings supported the experts' opinions that the lack of top management commitment and lack of exact assignment of roles and responsibility towards OE subfactors were primary barriers affecting the OE achievement in the Sudanese aviation industry.

The analysis of key barriers that hinder the achievements of OE in the Sudanese aviation industry pointed out some key shortcomings, such as the lack of understanding of the potential benefits of OE implementation, the lack of knowledge/understanding about the different OE models and approaches, the lack of linkages between improvement projects and OE results, the psychological inertia towards the advance OE techniques, poor measurement, analysis, and improvement system, and the lack of structured and straightforward approaches for OE in the aviation industry. These issues proved the needs for self-assessment tools that help the Sudanese aviation organisations to measure, analyse, and evaluate their performances and capabilities, especially in the organisational performance measures and benchmarking performances of within and among the organisations. To overcome the psychological barriers of the Sudanese aviation companies towards the international advanced OE frameworks, like the Shingo model, it is suggested that future studies should design and implement a simple, structured, practical, and integrated framework for OE. The framework can determine the opportunities for improvement, analyse the root causes, implement robust solutions, and sustain outstanding results from the improvement projects.

5. Conclusion

The topics of OE are increasingly gaining researchers' attention, especially in the field of applied sciences over the recent decades. However, past research have relatively over-emphasised the unilateral "result-driven" perspective of OE that corresponds with the limited concern for enablers, critical forms, and focus of OE. Thus, this paper attempted to address this issue. With the OE's conceptual framework, the CSFs to achieve OE were identified.

One limitation of this study is its generalisability across all Sudanese aviation industry. The research sets out to investigate the CSFs for the OE in its broadest sense, while it is anticipated that response rate and sample composition could negatively influence these study outcomes. Although the analysis shows no overall adversity between the responses for the Delphi questionnaire and panellists at the different sub-sectors in the Sudanese aviation industry, a limitation is an unlikelihood that all possible Sub-sectors in the Sudanese aviation industry are

represented adequately in the samples. For example, only one of the tenth Delphi panellists and a relatively small percentage of survey respondents represent the Aerial work and Crop protection services. Thus, although the differences are potentially marginal, the study outcome cannot be fully generalised across all Sub-sectors in the Sudanese aviation industry, especially those forming part of the Aerial work sub-category. This study also has other limitations, as with all research. The limited amount of research available on OE in the aviation industry and particularly in the Sudanese context has limited the opportunity to gather content-rich information from previous research. Additionally, the findings of the subfactors in this study were insufficient. So, future studies must focus on the detailed descriptions of subfactors related to each of the critical factors.

An organisation's OE is linked with organisational efficiency and effectiveness. In the competitive environment, every organisation is under intense pressure to reduce costs without decreasing the output and quality, often termed as efficiency. Efficiency in the organisations is generated and enhanced when the organisations become efficient in reducing time wastage, raw materials, unnecessary processing, and energy used in transportation, storing, and operating plant. Besides, the state of effectiveness is achieved when the organisation achieves its long-term goals through increased customer satisfaction and proves its reason for being. Therefore, OE is critical as it assures both the efficiency and effectiveness of organisations. From the five main factors, the expert panel members suggested that the leadership factor was the most important factor to achieve OE in the Sudanese aviation industry. The ranking of five CSFs and 40 subfactors provided a better understanding of the Sudan situation, specifically concerning the effective implementation of OE philosophy. In conclusion, the ranking introduced in this study can help in developing a robust framework for the OE achievement in the Sudanese aviation industry.

Declaration of Conflicting Interests

The authors declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

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