Prioritizing and Overcoming Barriers to Integrated Management System (IMS) Implementation Using AHP and G-TOPSIS

1. Introduction

To help improve overall efficiency and market competitiveness, organizations have been increasingly adopting and implementing multiple management systems standards (MSSs). This trend is visible from the increase in the number of most widely adopted standards such as quality and environmental management standards. We found the implementation of several standardized certifications in different organizations such as OHSAS 18001 for workplace health safety, SA 8000 and ISO 20000 for service management systems (SMS), ISO26000 for corporate social responsibility (CSR), ISO 27001 for information security, and ISO 10000 series for ensuring customer satisfaction. These typically build on prior efforts of standards such as ISO 9000 and continuous innovation efforts to improve firm performance (Latan, Jabbour, de Sousa Jabbour, de Camargo Fiorini, and Foropon, 2019).

Add to this the significance of MSSs proliferation is the advancement regarding their enactment. A review of the earlier studies by researchers such as (Simon et al., 2012b; Rebelo et al., 2016; Mustapha et al., 2017) have exposed this development and found that counties with a high rate of MSSs application (European Union) will soon experience a saturation point. On a country level, those that have recently promoted MSSs implementation see the spread of certificates in their early stages, and this trend will only continue to increase. These efforts to enable MSSs contributes to knowledge management, and new frameworks for enhancing public sector performance (Al-Ahbabi, Singh, Gaur, and Balasumbramanian, 2017), but do not come without some resistance to change.

Several factors have been limiting the process of integration and, simultaneously, the benefits of these systems. A relatively important factor among these is the type of model used during implementation. Some models have been considered incompatible by Nunhes et al. (2017). Others suggest that proper motivation of human resources plays a vital role in the process (Domingues et al., 2016; Domingues et al., 2015; Simon et al., 2012a; Sroufe, 2017). Also important is the order of processes in implementation (Ikram et al., 2019; de Oliveira, 2013). These factors work as difficulties for the process of integration and they can bring heterogeneous effects in different organizations. Overcoming these difficulties is the goal of organizations with many management system strategies in hand, as they implement these policies for the better management of the organization and ultimately the exploitation of related synergies (Asif et al., 2013a; Zutshi and Sohal, 2005; Samani et al., 2019).

When considering how these systems are supported and deployed, management of them becomes more complex because of the increasing number of performance measures integrated across functions. This, in turn, can cause difficulties in system implementation and control, high costs, unreasonable obstacles from bureaucracy. Taking into account the similar structure of business systems, an Integrated Management System (IMS) appears to be an appropriate strategy for managing the complex, diverse expectations and demands of stakeholders (Baumgartner and Rauter, 2017). The IMS functionality found in different systems (OHSMS, CSRMS, QMS, EMS), can be integrated gradually to provide better management, i.e., that saves time, resources, diminishes efforts by eliminating duplicate documentation, duties, and other administrative efforts (Gianni et al., 2017). However, there is no global benchmark and "standardized" integration process of management systems that can address the preeminent process necessary to carry out it. There are, however, nationally recognized procedures (SAI Global, 1999; Dansk Standard, 2005; AENOR, 2005; BSI, 2006) an international handbook (ISO, 2008b), and service management systems with ISO 20000 (Ahmad, Rabbany and Mithum Ali, 2019) available to help organizations develop and integrate standardized MSs.

According to a review by (Tepaskoualos and Chountalas, 2017), some earlier studies in the field concluded that both the application and supplementary certification of MSs strategies by enterprises considerably add to enhancements in complete organizational performance; including financial performance (Sroufe and Gopalakrishna-Remani, 2018). The process of integration in the organizations begins with the availability of one MS standard for certification, which motivates managers to avail further MSs in the same company without any "strings attached." This approach explicitly contradicts the best practice of management (Del Mar Alonso-Almeida et al., 2014). Also, the MSs more often implemented and certified share the same idea (unceasing enhancement by the implementation of the Plan Do Check Act (PDCA) sequence), as well as the same main beliefs and ethics (Salah et al., 2010). Researchers have found that companies in different sectors of the economy have integrated MSs in their operations. There are a number of implementation methods and different strategies employed. In light of the above, important research questions include how to compare IMSs, and how can the integration process be more effective? Our intent with this study is to fill this gap in the research while trying to understand "how" and "why" organizations assess the difficulties of IMSs for more optimal utilization of available resources.

In doing this, we also need to unpack the multiple criteria available to managers when making decisions about IMS implementation options. For this, we use analytical hierarchy process (AHP) methods to calculate the weights of the elements (dimensions, criteria and indicators), and with the help of order preference by similarity to ideal solutions (TOPSIS) we can take this a step further to obtain the final ranking of the alternative closest to the ideal solution. Some of the advantages of using techniques for TOPSIS methods include simplicity, rational, comprehensibility, and good computational efficiency with the ability to measure the relative performance for alternatives in a simple mathematical form.

The contributions of this study are in providing new insights regarding levels of integration and employee motivation as important to overcoming barriers to implementation. Additionally, we see the AHP results as a foundation for understanding important and less important criteria for decision-makers and researchers as we uncover new insights as to meaningful subcriteria. Additional contributions come from the application of a Grey group TOPSIS method as this can help extend prior findings and help prioritize the best alternatives to enhance and validate the consistency of results.

From the literature, it is possible to describe basic elements and factors that provide a starting point for research and critical success factors for these systems. To start, we build on the literature while producing a summary list of metrics and indicators important to IMSs implementation. We also identify a literature gap regarding the choice and definition of the barriers of IMSs as we believe this has not been adequately investigated. The primary research questions addressed in this study are what are the most important criteria, i.e., barriers, for an IMS and how can they be prioritized in a way that adds value for both practitioners and researchers? From the literature review, we are able to identify six main barriers and 26 sub-barriers. We then review the applicable research methods. Here, we show how AHP is a viable technique for allocating weights to both barriers and sub-barriers utilizing a previously tested matrix of pairwise comparisons from prior research (Handfield et al., 2002). Building on the AHP technique, we next use a Grey TOPSIS method for the classification of the priorities and alternatives. The rest of the paper presents the MCDM methodology, findings and discussion. Finally, we develop the conclusions in the last section.

2. Literature Review

Management systems integration combines management system functions into a single multifunctional effective system with dynamic benefits (Sampaio et al., 2012; Wardell, 2019). Specific management systems can be taken into consideration during the integration process enabling functionality beyond existing standards (Souza, and Alves, 2018; Domingues et al., 2015; Robson et al., 2012). There are several aspects to consider but the most important during the process of management system integration are implementation strategy, integration methodology, audit integration and the level of integration (Bernardo et al., 2018). The first aspect concerns the implementation sequence applied to the management system as organizations have implemented management standards in varying sequences or levels of the organization. For example, organizations have implemented a quality management system (ISO 9001) first, and then an environmental management system (ISO 14001) second, or adapted a different strategy; implementation both of these MSs simultaneously (Tepaskoualos and Chountalas, 2017; Rebelo et al., 2014; Ikram et al., 2019). The second aspect regarding management system integration is integration methodology, in this respect, several international standards are available to develop integration system International Organization for standardization (ISO), SAI Global, Global Reporting Initiative (GRI), and British Standard Institutions (BSI). For the development of IMS, ISO has published manuals with integration methodology and guidelines. There are also a variety of integration methodologies (Zeng et al., 2007; Simon and Douglas, 2013; Ikram et al., 2019). The third and fourth aspects address the integration level of MSs and integrated audits to be achieved by integration process i.e. three levels of integration have been identified and discussed in literature such as no integration means separate implementation. Partial integration implies the integration of audits but the documentation process is kept separate. Full integration, in which all the management standards functions are at an integrated level. Bernardo et al. (2009) conducted a study with a sample of 435 Spanish companies to investigate the level of integration, around 86% of the companies either integrate partially or fully their management systems. They could identify MSs important points with a high level of integration, categorizing these points into three main branches, objectives, resources and procedures. They also observed that organizations start their integration process with setting strategic goals, integration of documentation and procedures such as integrated quality environment and social (QES) policy, standard operation procedures (SOPs), document control and traceability mechanism, annual audit plans and a semiannually Management Review Meeting (MRM). In Table 2, we can see from the literature; there are a lot of approaches/methods used in IMS studies. To the best of the author knowledge none of them used AHP and Grey TOPSIS method to prioritize and overcome the IMS barriers.

Table 1: Method/approach used in IMS studies

NO	IMS research conducted	Method/ Approach	Year	Reference
01	A synergetic model for implementing an IMS	Structural Equation Model (SEM)	2007	(Zeng et al., 2007)
02	An IMS model based on Total Quality	Survey study	2001	(Wilkinson and Dale, 2001)
03	IMS: three different levels of integration	Qualitative study	2006	(Jørgensen et al., 2006b)
04	Synergies in standardized management systems: some empirical evidence	Survey study	2011	(Casadesús et al., 2011)
05	Musings on integrated management systems	Qualitative study	2003	(Karapetrovic, 2003)
06	IMS: Experience of Indian Manufacturing organizations, Key Findings	Survey study	2010	(Khanna et al., 2010)
07	Integration of ISO 9001, ISO 14001 and OHSAS 18001 for construction companies	Survey study	2005	(Pheng and Kwang, 2005)
08	IMS guiding principles	Review study	2019	(Nunhes et al., 2019)
09	Trends of IMS	Survey study	2017	(Ribeiro et al., 2017)
10	IMS: Experiences of Australian organizations	Survey study	2005	(Zutshi and Sohal, 2005b)
11	Assessment of IMS: a maturity model proposal	Survey study	2016	Domingues et al. (2016)
12	IMS and Sustainability performance	Qualitative study	2017	(Gianni et al., 2017)
13	Identification and analysis of the elements and functions integrable in integrated management systems	Qualitative study	2017	(Nunhes et al., 2017)
14	Lean-integrated management system: A model for sustainability improvement	Qualitative study	2018	(Souza and Alves, 2018)
15	Do integration difficulties influence management system integration levels	Structural Equation Model (SEM)	2012	(Bernardo et al., 2012)
16	resources for Integrated Management Systems within resource-based and contingency perspective	Structural Equation Model (SEM)	2015	(Savino and Batbaatar, 2015)
17	An integrated management systems approach to corporate social responsibility	Qualitative study	2013	(Asif et al., 2013a)
18	Integration and organizational change towards sustainability	Survey study	2017	(Sroufe, 2017b)
19	IMS towards sustainable and socially responsible firms	Survey study	2015	(Mežinska et al., 2015)

20	Integration of quality and environmental management practices affect firm performance? Mediating roles of quality performance and environmental proactivity	Structural Equation Model (SEM)	2018	(Arda et al., 2018)

The integration of MSS depends on many parameters apart from the cost of implementing a change, such as resource availability, competency, and having the required expertise. These parameters include the type and nature of the organization (e.g., large/medium/small), complexity of business (regional/national/international, single/multiple locations), type of integration (partial/full alignment and integration), the nature of business operations, and processes of the organizations intending to do integration of MSS. The challenges and difficulties in the integration of MSS and implementation of an IMS include but are not limited to: internal barriers (resources, people, and implementation), and external barriers (economic, social & legal, and cultural). Organizations should consider resource limitations in implementing IMS. They may not be able to afford to include all management systems in their IMS. However, to cope with organizational interdependencies with strategic benefits that come from the allocation of scarce resources, there is a need to overcome the difficulties during the implementation of an IMS. Santos et al., (2011) developed an appropriate model, which helps organizations in the selection of relevant MSs within resource constraints for better management of organizational requirements. By understanding and being aware of the challenges/impediments in IMS implementation, organizations can successfully implement IMS by adopting a planned approach by properly addressing these challenges through appropriate strategies. The lessons learned by those organizations successfully implementing IMS can be used as recommendations for other organizations wanting to integrate their MSS. Recommended approaches by Khanna et al., (2010), Arda et al., (2018), and Hernandez-Vivanco et al., (2018) are: top management commitment & management review, provision of resources, appointing a champion, training, process control, documentation system/control, auditing and addressing waste issues, cultural transformation, cooperation and coordination over the entire supply chain, communication, continual improvement and unwavering focus on the stakeholders. These recommendations can facilitate the efficient and smooth integration of MSS for those organizations willing to implement IMS.

There are a lot of barriers that hinder the effective implementation of IMSs. These barriers can create confusion, and in turn, demotivate employees and affect sub-optimal performance (Sroufe, 2017; Asif et al., 2013b). Organizations need effective utilization of organizational resources for the integration of individual MSs, and for organizational innovation (Busaibe, Singh, Ahmad, and Gaur, 2017). IMSs required resources such as personnel, time and cost that can create additional pressure on organizations. This can lead to a number of hurdles during the implementation of IMS. From the literature, we have identified the barriers of IMS found in Table 2.

Table 2: Classification of IMS barriers

Criteria	Sub-criteria	References
Resource and Management (RM1)	Insufficient Financial and human resources (RM-11) Lack of information, expertise, and insufficient training (RM-12) Lack of Time and time delays in integration (RM-13) Lack of management and administration support (RM-14) Lack of strategic planning (RM-15) Inadequate audit methodologies and lack of specialized auditors (RM-16)	(Ikram et al., 2019; Asif et al., 2019; Gianni and Gotzamani, 2015; Bernardo et al., 2015)
People (PE2)	Lack of proper attitude and perception (PE-21) Lack of employees motivation (PE-22) Employees resistance towards change (PE-23) Employees refusing in order to integration of functions (PE-24) Beware of integration process (PE-25)	(Curkovic and Sroufe, 2011; Handfield et al., 2015; Jurburg et al., 2017; Ciravegna Martins da Fonseca et al., 2017; Tortorella et al., 2019; Severo et al., 2017),
Implementation (IM3)	Multiple requirements of each management systems (IM-31) Different approach of each MSs (IM-32) Misunderstanding of integration concepts & lack of guidelines (IM-33) Reduced flexibility after integration (IM-34) Increase in bureaucracy due to intertwining (IM-35)	(Rebelo et al., 2016; Carvalho et al., 2018; Domingues et al., 2015; Asif et al., 2013)

Economics (EC4)	Insufficient drivers and benefits (EC-41) Uncertainty about value of IMS (EC-42)	(De Oliveira, 2013; Franco-Santos and Otley, 2018; Zhu et al., 2013; Baumgartner and Rauter, 2017; Ikram et al., 2019)
Social and Legal (SL5)	Lack of support schemes and guidance (SL-51) Varying demands from different stakeholders (SL-52) Continually changing regulations & guidelines (SL-53) Conventional IMS Unavailability (SL-54) Inconvenience of universal denominator (SL-55)	(Su et al., 2015; Shah and Shrivastava, 2014; Savino and Batbaatar, 2015; Souza and Alves, 2018)
Cultural (CL6)	Requires cultural transformation (CL-61) Lack of communication and team work (CL-62) Varying culture and personality clashes (CL-63)	(Bierema and Callahan, 2014; Longenecker and Fink, 2015; Brudan, 2010; Navimipour et al., 2018)

Implementation of MSs develops an infrastructure to fulfill stakeholder requirements in a coordinated way. A good IMS design can influence organizational structure in such a manner that removes the conflict of conflicting stakeholder requirements (Domingues et al., 2015). At a strategic level, an IMS provides a mechanism for increased interactions with stakeholders, a means of developing an informed understanding of their demands, and a way to structure the effective and efficient channeling of organizational resources (López-Fresno, 2010). At a tactical level, it emphasizes the development of integrated documentation enabling job responsibilities, work instructions, SOP's, and inline processes. As well as a clan and adaptive organizational culture, along with criteria and norms by which they can effectively implement the IMS. To help these efforts, organizations need to deliver employee training regarding instructions for work integration at the operational level. Moreover, monitoring through integrated auditing with administration support helps to build strong stakeholder relationships to promote efficiency, save resources, and reduce confusion amongst employees at the operational level (Asif et al., 2008).

Management systems integration has included numerous methods along with classifications of barriers. The purpose of this study is to build on the literature and apply a modified Delphi methodology to an Analytical Hierarchy Process (AHP) and Grey TOPSIS methods to select optimal solutions for organizing IMS barriers. Since we are not evaluating dependent and independent variables, we are not looking to propose hypotheses, but instead calculate priority weights of criteria and alternatives. Hypotheses are not required when using AHP however the research framework should reflect the criteria & sub-criteria, which is what we have been able to do in this study. The literature helps to establish the criteria and subcriteria used for experts to review and perform pairwise comparisons to help rank the perceived importance of the criteria. Next, we review the research framework and insights from experts leading up to the analysis and results in subsequent sections.

3. Research framework

After a review of methods to help organize and analyze complex attributes of IMSs, we found multi-criteria decision analysis as a generalizeable approach to decisions with dependence and feedback. For this study, we have applied the AHP and Grey TOPSIS methods to select the optimal solution for organizing IMS barriers. Figure 1 represents the framework for our study in which the AHP method is used as an initial start-up level of application with the help of decision-makers to calculate the weights of main criteria and sub-criteria using a pairwise comparison matrix. Next, a grey-based TOPSIS technique is employed to determine the optimal solution of IMS implementation based on alternatives. Grey theory is often applied to new fields, (Rahman, Tumpa, Ali, and Paul, 2018), and is a good fit for application to IMS implementation.

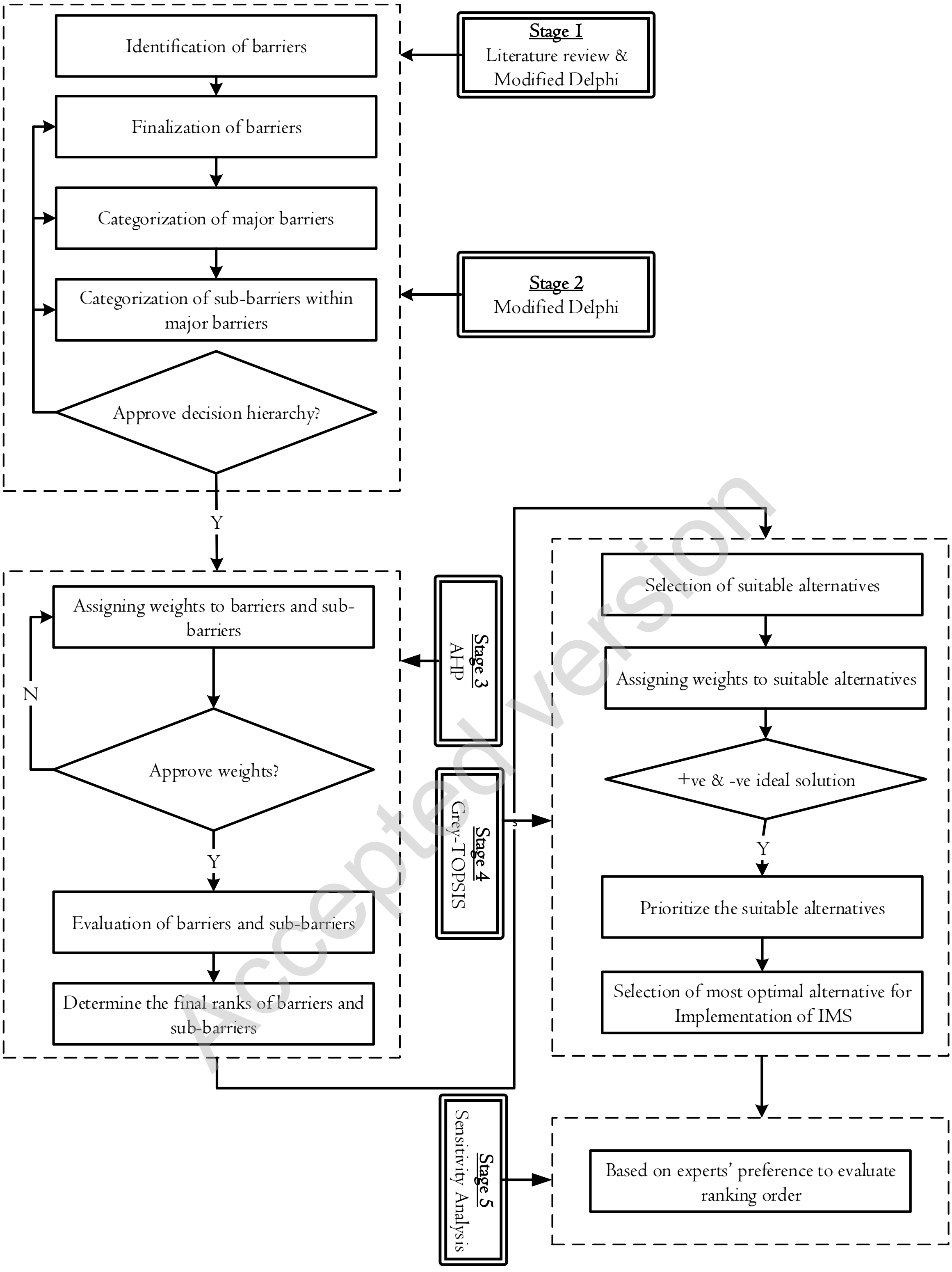

***Figure 1**: Framework of the study*

Descriptions of Modified Delphi method AHP and grey TOPSIS processes are as follows.

3.1. Modified Delphi Method

We used Modified Delphi method to finalize and classify IMS barriers. This method enables a systematic way to gather expert's opinions by questionnaire and group discussion where relevant experts share their knowledge, expertise, and suggestions to finalize the barriers through mutual consensus (Shah et al., 2019). To make these mutual assumptions this method comprises five stages, i.e. selection of relevant field experts, second and third step involved a dual round of questionnaire survey, filtration of expert's feedback's and finally, finalizing the barriers. Steps 3 and 4 are repeated until there is mutual consent by decision-makers (Solangi et al., 2019).

We did not find a standard available in the literature for a requisite number of experts selected for the survey. Several studies used a different number of experts to obtain reliable results; for example Bouzon et al., (2016) surveyed 16 experts to obtain scores for the analyses of reverse logistic barriers by using the MCDM method. Whereas, Zare et al., (2018) surveyed 5 experts for VIKOR and TOPSIS analysis. In this study, we conducted an online survey with the help of 10 experienced experts before applying the AHP and GTOPSIS methods. The participants were academic professors, research analysts, policymakers, stakeholders, and managers. Participants were asked to give scores based on TFN and grey linguistic variables to prioritize and overcome the IMS barriers. The experts have more than 15 years' work experience, and they are very familiar with the industry and the IMS research context.

3.2. Analytical Hierarchy Process (AHP)

AHP is one of the important and widely used MCDM methods to provide a solution for composite decision-making problems. In the 1970s, Thomas L. Saaty introduced the concept of AHP (Harker and Vargas, 1987). The primary components of AHP comprise of pairwise comparisons, developing and comparing matrices and checking their consistency. This technique helps all decision-makers to rationally select and rank complex problems. The key AHP methodology steps are as follows (Saaty, 1990).

Level 1. Developing the hierarchal structure of the decision-problem.

Level 2. Using Saaty's point scale 1-9 for Pair-wise comparisons matrix for the decision-problem

Level 3. Calculating a consistency Index (CI).

To check the consistency of the pair-wise comparison of the matrix, CI is used at this level. The formula of CI as follows (Cavallo, 2017).

$$CI = \frac{\lambda_{max} - n}{n-1} \quad (1)$$

here λ_{max} indicates the eigenvalue and n represent the no. of main criteria

Step 4. Computing the Consistency Ratio (CR)

$$CR = \frac{CI}{RI} \quad (2)$$

Table 3 presents the random consistency index RI. The values of RI must be within a consistent region limit of 0.1. If the value of consistency ratio (CR) exceeds this limit, then the results could be considered inconsistent.

Table 3. Random Index (RI)

n	1	2	3	4	5	6	7	8	9	10
RI	0.00	0.00	0.058	0.90	1.12	1.24	1.32	1.41	1.45	1.49

In this study, the AHP method provides the weights of the main barrier and sub-barriers after the accomplishment of all steps. These weights are utilized in the Grey group TOPSIS method to prioritize the proposed optimal solution to overcome the barriers during the implementation of IMS (i.e., the alternatives). The TFNs rating scale frequently employed in MCDM problems is shown in Table 4.

Table 4. Linguistic variables with Fuzzy number

Number	**Linguistic Variables**	**TFNs**
1	Highly unfavorable (HU)	(0,0.05,0.15)
2	Unfavorable (U)	(0.1,0.2,0.3)
3	Fairly (F)	(0.2,0.35,0.5)
4	Favorable (F)	(0.3,0.5,0.7)

5	Highly Favorable (HF)	(0.5,0.65,0.8)

3.3 Grey Numbers

The interval of the unknown and known values is called the grey number. This interval comprises partial/incomplete system data. The grey number is denoted with the symbol$\otimes$. There are several types of grey numbers. Within this study, we introduce three types as follows (Liu et al., 2017):

Type (1): If $\otimes B$ is a grey number whose lower bound can only be calculated, it is known as a grey number with only a lower bound and is indicated as $\otimes B = [\, \underline{B} \,, \infty)$.

Type (2): If $\otimes B$ is a grey number whose upper bound can only be calculated, it is known as a grey number with only upper bound and is indicated as $\otimes B = (\, \infty \,, \overline{B} \,]$.

Type (3): If $\otimes B$ is a grey number whose lower and upper bounds can be calculated, it is known as an Interval grey number and is indicated as $\otimes B = [\, \underline{B} \,, \overline{B} \,]$.

If $\otimes B = [\, \underline{B} \,, \overline{B} \,]$ and $\otimes C = [\, \underline{C} \,, \overline{C} \,]$ are two grey numbers, then arithmetic operations can be written on them as Eqs. (3) to (6):

$$\otimes B + \otimes C = [\, \underline{B} + \underline{C} \,, \overline{B} + \overline{C} \,] \tag{3}$$

$$\otimes B - \otimes C = \otimes B + (- \otimes C) = [\, \underline{B} - \overline{C} \,, \overline{B} - \underline{C} \,] \tag{4}$$

$$\otimes B \times \otimes C = [\, Min \{\underline{B}\,\underline{C}, \overline{B}\,\overline{C}, \overline{B}\,\underline{C} \,, \underline{B}\overline{C} \}, Max \{\underline{B}\,\underline{C}, \overline{B}\,\overline{C}, \overline{B}\,\underline{C} \,, \underline{B}\overline{C} \} \,] \tag{5}$$

$$\begin{aligned} \frac{\otimes B}{\otimes C} &= \otimes B \times \otimes C^{-1} \\ &= \left[Min \left\{ \frac{\underline{B}}{\underline{C}}, \frac{\underline{B}}{\overline{C}}, \frac{\overline{B}}{\underline{C}}, \frac{\overline{B}}{\overline{C}} \right\}, Max \left\{ \frac{\underline{B}}{\underline{C}}, \frac{\underline{B}}{\overline{C}}, \frac{\overline{B}}{\underline{C}}, \frac{\overline{B}}{\overline{C}} \right\} \right] \end{aligned} \tag{6}$$

The length of the grey number $\otimes B = [\, \underline{B} \,, \overline{B} \,]$ is come by Eq. (7):

$$L(\otimes B) = \overline{B} - \underline{B} \tag{7}$$

If $\otimes B = [\, \underline{B} \,, \overline{B} \,]$ and$\otimes C = [\, \underline{C} \,, \overline{C} \,]$, represent two grey numbers; the degree of greyness between these two numbers is obtained using Eq. (8) (Bakar et al., 2019). This study used the Grey linguistic variables based on grey numbers to check the impact of alternatives presented in Table 5

$$P\{\otimes \boldsymbol{B} \leq \otimes C\} = \frac{Max\{0, L^{*} - Max(0, \overline{B} - \underline{C})\}}{L^{*}} \quad \text{Where } L^{*} = L(\otimes B) + L(\otimes C) \tag{8}$$

Table 5: Grey linguistic variables with Grey numbers

High unfavorable	Unfavourable	Favorable	Fairly Favorable	Higly Favorable
V W	W	M	G	V G
[0.0,0.2]	[0.2,0.4]	[0.4,0.6]	[0.6,0.8]	[0.8,1.0]

3.4 Grey Group TOPSIS (G-TOPSIS) Method

In 1981 the concept of TPOSIS was introduced by Huang and Yun, in which n alternatives are ranked by the m criteria. The advantage of the TOPSIS method is that it provides both the positive and negative ideal solutions to a problem. Meanwhile, the positive ideal solution depicts the increase in profit and a reduction in cost standards. Further, the selection of optimal alternatives is based on the least distance from the positive ideal solution and maximum distance from the negative solution. Taking into account the benefit of the Grey system ensures accuracy in the assessment of uncertain system data. We define the steps of G-TOPSIS method as fellow below (Zare et al., 2018)

Stage 1: First, we calculate the weights of each criterion based on expert opinion by using grey linguistic variables is in Table 4. Assuming that the number of decision-makers is e, we can compute the criterion g weight of alternatives using Eq. (9).

$$\otimes w_g = \frac{1}{e}\left[\otimes w_g^1 + \otimes w_g^2 + \cdots + \otimes w_g^e\right] \tag{9}$$

Stage 2: The Grey linguistic variables should be used to check the status of each research alternative in each of the criteria. Assuming that the number of decision-makers is e, the value of alternative h in the criterion g is calculated using Eq. (10).

$$\otimes G_{hg} = \frac{1}{e}\left[\otimes G_{hg}^1 + \otimes G_{hg}^2 + \cdots + \otimes G_{hg}^e\right] \tag{10}$$

Stage 3: Propose the grey decision matrix can be written in Eq. (11).

$$E = \begin{bmatrix} \otimes G_{11} & \otimes G_{12} & \dots & \otimes G_{1n} \\ \otimes G_{21} & \otimes G_{22} & \dots & \otimes G_{2n} \\ \vdots & \vdots & \vdots & \vdots \\ \otimes G_{m1} & \otimes G_{m2} & \dots & \otimes G_{mn} \end{bmatrix} \tag{11}$$

In Eq. (21), $\otimes G_{hg}$ shows the importance of the alternative h in the criterion g.

Stage 4: Normalize the grey decision matrix is (12)

$$E^* = \begin{bmatrix} \otimes G_{11}{}^* & \otimes G_{12}{}^* & \dots & \otimes G_{1n}{}^* \\ \otimes G_{21}{}^* & \otimes G_{22}{}^* & \dots & \otimes G_{2n}{}^* \\ \vdots & \vdots & \vdots & \vdots \\ \otimes G_{m1}{}^* & \otimes G_{m2}{}^* & \dots & \otimes G_{mn}{}^* \end{bmatrix} \tag{12}$$

If the criteria of benefit attribute, Eq. (13) is used for normalization.

$$G^*{}_{hg} = \left[\frac{\underline{G}_{hg}}{G_g^{max}}, \frac{\overline{G}_{hg}}{G_g^{max}} \right] \text{Where } G_g^{max} = max_{1 \le g \le m} \{ \overline{G}_{hg} \} \tag{13}$$

If the criterion is of cost attribute, Eq. (14) is used for normalization.

$$G^*{}_{hg} = \left[\frac{G_g^{min}}{\overline{G}_{hg}}, \frac{G_g^{min}}{\underline{G}_{hg}} \right] \text{Where } G_g^{min} = min_{1 \le g \le m} \{ \underline{G}_{hg} \} \tag{14}$$

Grey matrix values will be in the range [0,1] after the normalization process.

Stage 5: A weighted normalized grey decision matrix is formulated at this stage as expressed in Eq. (15).

$$X = \begin{bmatrix} \otimes X_{11} & \otimes X_{12} & \dots & \otimes X_{1n} \\ \otimes X_{21} & \otimes X_{22} & \dots & \otimes X_{2n} \\ \vdots & \vdots & \vdots & \vdots \\ \otimes X_{m1} & \otimes X_{m2} & \dots & \otimes X_{mn} \end{bmatrix} \text{Where } \otimes X_{hg} = \otimes G_{hg}^* \times \otimes w_g \tag{15}$$

Stage 6: The value of positive and negative ideal solutions can be computed by Eqs. (16) and (17).

$$S^{max} = \{ [max_{1 \le g \le m} \underline{X}_{h1}, max_{1 \le g \le m} \overline{X}_{h1}], [max_{1 \le g \le m} \underline{X}_{h2}, max_{1 \le g \le m} \overline{X}_{h2}], \dots, [max_{1 \le g \le m} \underline{X}_{hn}, max_{1 \le g \le m} \overline{X}_{hn}] \} \tag{16}$$

$$S^{min} = \{ [min_{1 \le g \le m} X_{h1}, min_{1 \le g \le m} \overline{X}_{h1}], [min_{1 \le g \le m} X_{h2}, min_{1 \le g \le m} \overline{X}_{h2}], \dots, [min_{1 \le g \le m} \underline{X}_{hn}, min_{1 \le g \le m} \overline{X}_{hn}] \} \tag{17}$$

Stage 7: The calculation of the degree of greyness between the ideal solution and alternatives is in Eq. (18).

$$A\{S_h \leq S^{max}\} = \frac{1}{n}\sum_{g=1}^{n} A\{\otimes X_{hg} \leq \otimes G_g^{max}\} \tag{18}$$

Stage 8: An ascending order was set for alternatives, and considers a high priority with lowest degree of greyness based on the values obtained in step 7.

4 Results and Discussion

This study presents how the integration of the AHP and Grey TOPSIS approach enables decision-makers, planners, and policymakers to effectively implement IMS and assess a strategic decision-making process. It is the first kind of study to provide an optimal solution to reduce the barriers of IMS by prioritizing the main barriers and sub-barriers of IMS using a combined AHP and grey TOPSIS approach. Our investigation of IMSs lays a foundation for corporations and decision-makers to further determine the application and research framework within this study, providing a suitable rationale for the effective implementation of IMS.

4.1 AHP results

We start with a pairwise comparison matrix of the AHP method employed to calculate the individual expert weight scores using a geometric mean (Krejčí and Stoklasa, 2018). This study employed the group-based decision-making approach for the calculation of IMS barriers and sub-barriers weights. Based on the literature review, we considered six main barriers, i.e., Resources and Management, People, Implementation, Economic, Social and Legal, and Cultural, for our AHP model analysis. In the first stage of the AHP method, the 6 main barriers weights were obtained, and in the second stage, we evaluated 26 sub-barriers. The hierarchal structure of IMS barriers and sub barriers is in Fig. 2.

4.1.1 The Ranking of the main barrier's

The AHP technique determined the weight of each main barrier hierarchically. The main barriers are in Table 6 and reveal that implementation is the most influencing barrier with a weight of (0.2523) followed by Social & Legal (0.2175), Resources and Management

(0.1829), Cultural (0.1361), Economics (0.1199) and People (0.0913) criteria, respectively. Each of the detailed main criteria weights are in Fig 3. The ineffective management systems implementation is the most influencing barrier in the implementation of IMS. This can, in turn, affect overall business performance. Social & Legal is the second most influencing barrier in this study after Implementation.

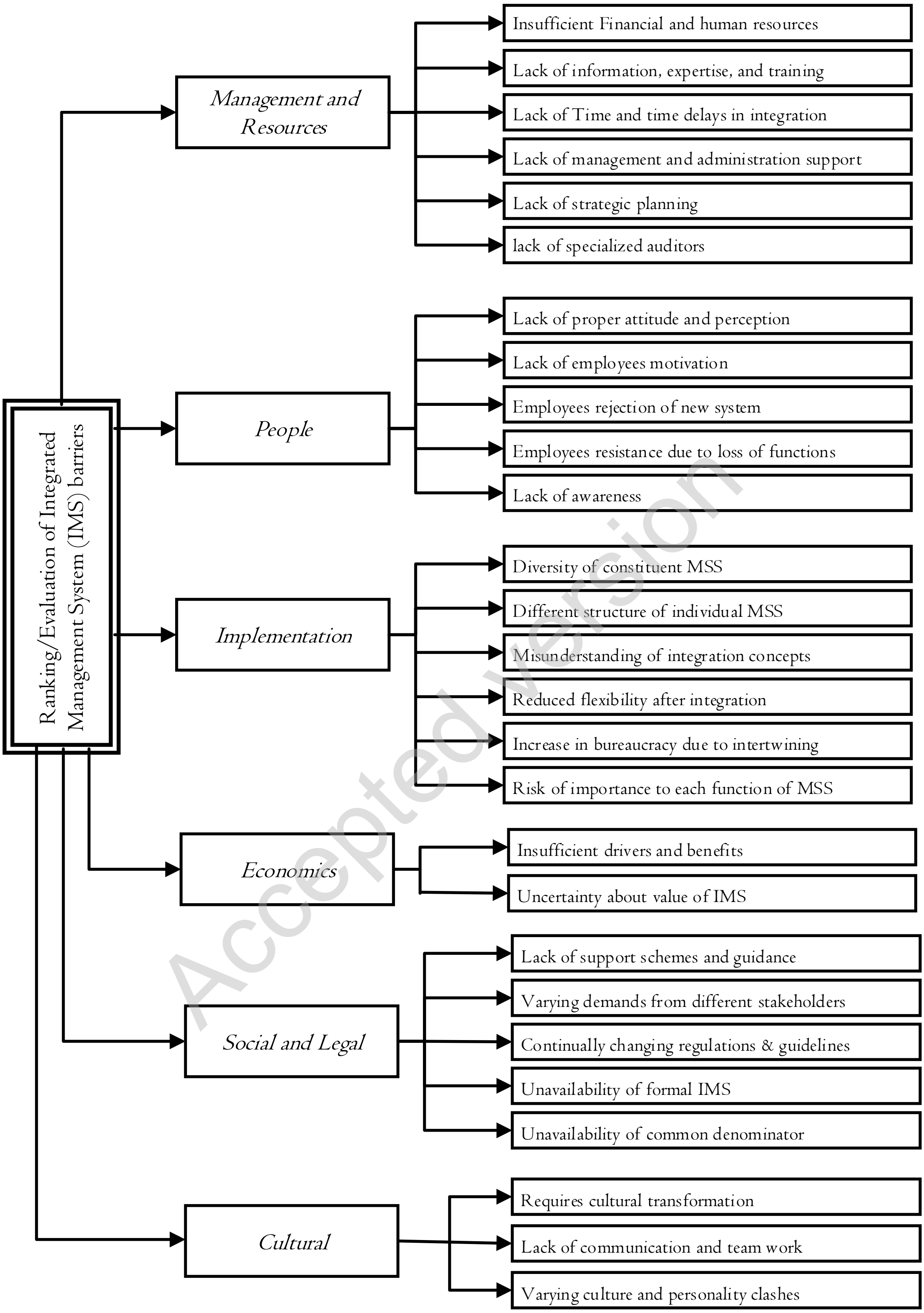

***Figure 2**: Hierarchal structure of IMS barriers*

Both the Implementation barrier and Social & Legal barriers can take place simultaneously. The timing of barriers implicitly determines a strategy for integration. Due to the new advancements of MSs, it brings new regulations and compliance parameters that appear to be a challenge for organizations. Therefore, organizations need to continuously update their procedures and systems to enable more sustainable practices and to maintain compliance.

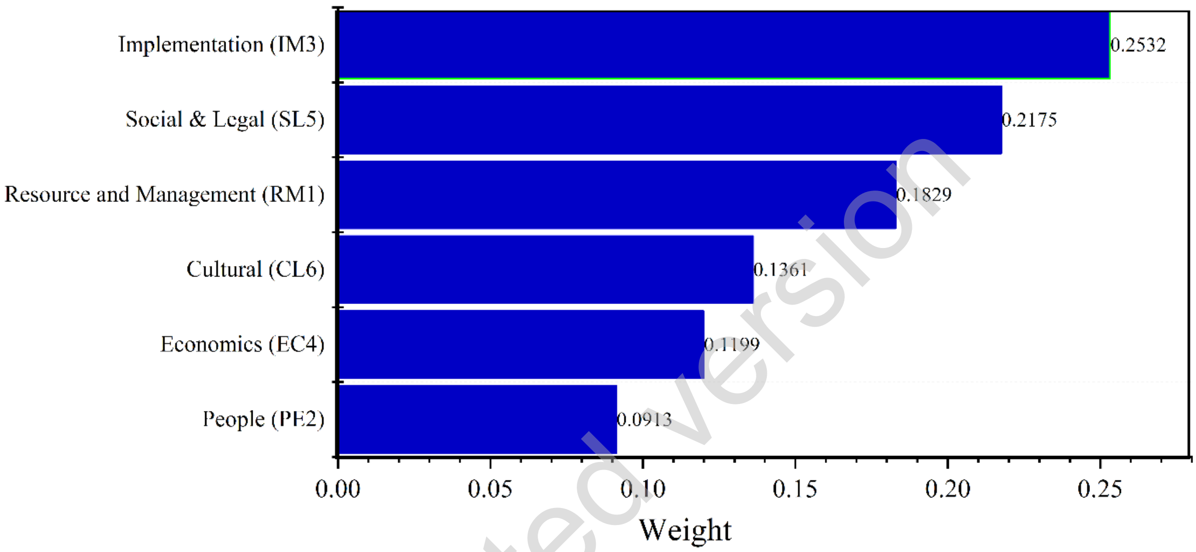

Fig.3. *The ranking of main barriers in the implementation of IMS*

According to the weight calculations of the main barriers of the study, Resource Management and Culture barriers took their places as the third and fourth priorities. To this end, organizations should consider resource limitations in implementing IMS and carefully prioritize investments and timelines. Hence, organizations should design a structure that can overcome the discrepancies and construct a model for a more optimal MS's focused on organizational benefits while better utilizing scarce resources. Organizations need to adapt a willingness to accept change culture to effective implementation of IMS. Economics is the fifth barrier. This can be impacted by high development costs and time overruns, the addition complication of multiple systems when compared to the individual system, too many parallel actions at a given time, limitation in the choice of certification bodies, difficulty in organizing, and managing audits along with management expectations.

Table 6: Ranking of the main criteria

Main Criteria	Code	Weight	Rank
Implementation	IM3	0.2523	1st
Social & Legal	SL5	0.2175	2nd
Resources and Management	RM1	0.1829	3rd
Cultural	CL6	0.1361	4th
Economics	EC4	0.1199	5th
People	PE2	0.0913	6th

Finally, People is considered the least influential criteria, having the least weight determined by fuzzy AHP in the implementation of IMS. A lack of willingness of the employees to adopt change within an organization can affect implementation and maintenance of IMS. Further, the 26 sub-barriers of the study were assessed through expert's feedback using a pairwise comparisons matrix.

4.1.2 The ranking of sub-criteria

This section addresses the result of all sub-barriers in Figure 4 to 9.

Resource and Management sub barrier's: The ranking of sub-barriers within the category (RM1) is as follows: RM12>RM11>RM14>RM13>RM16>RM15

Lack of information, expertise, and insufficient training came first and appeared the most important and influencing sub-barrier of (RM12) with a weight of 0.0687. This ranking represents some face validity as an accurate justification as audit expertise and trained teams are often given credit for effective IMS implementation. Unavailability of certified auditor/expert or well-trained team appears a common challenge faced by most of the organizations when implementing an IMS. Due to limited resources, organizations also face difficulties hiring an expert with the appropriate salary.

The second highest weight obtaining sub-barrier within the category is insufficient financial and human resources (RM11) with a weight of 0.2219. Other studies have found that when the organization sets composite goals by integrating inter-connected processes comprising stakeholder relationships, human capital, infrastructure, and financial benefits this helps to achieve sustainable development.

Lack of management and administration support (RM-14) has a weight of 0.2109 and is the third most important sub-criteria within the category in Fig. 4. Difficulties/challenges of IMS within the literature focus on the roles of top management support and organizational commitment as vital to the implementation of IMS. Line managers consequently need to be involved for IMS to be successfully implemented and should participate in the maintenance of IMS.

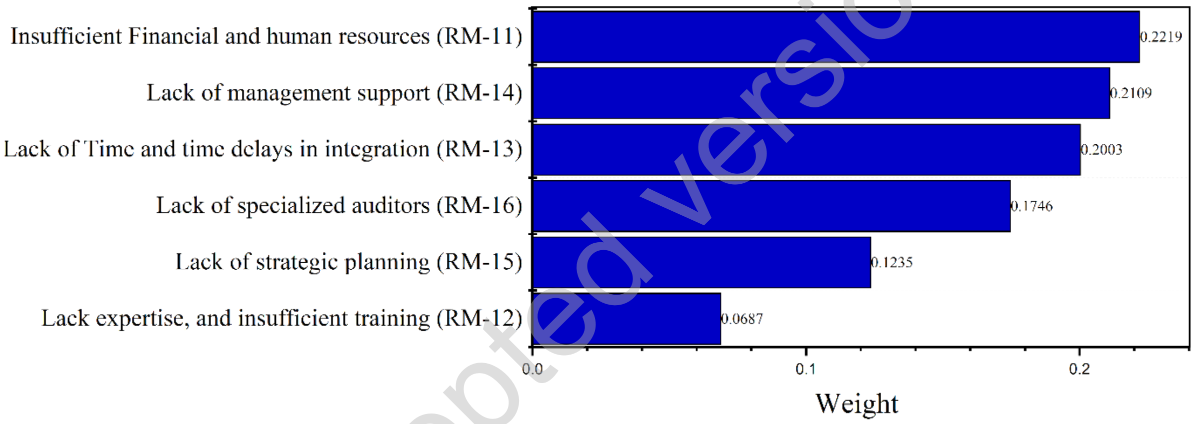

Fig. 4. *The ranking of Resource and Management sub barriers*

Lack of Time and time delays in integration (RM-13) received 0.2003 weight as the 4th most important sub-barrier within the category. Further, Inadequate audit methodologies and lack of specialized auditors (RM-16) has a weight of 0.1746 in the 5th position. Integrated audits are more effective than audits with different audit teams advising an organization and you can improve workforce skills by integrating training and development. The integration of audits also motivates the employees to properly align their activities and responsibilities with IMS (Guerrero-Baena et al., 2015). Lastly, the lack of strategic planning (RM-15) sub-barrier is 0.1235 and is sixth in the order.

People: Under the people (PE2) category, the ranking of sub barriers is obtained as follows PE-22>PE-25>PE-24>PE-23>PE-21, and presented in Fig. 5. Lack of employee motivation (PE-22) is a challenge to support the implementation of IMS with a weight of 0.3405. The results illustrate that organizational strategy should strongly consider employee motivation for the implementation of IMS. Therefore, a high level of employee motivation, in turn, would provide benefits such as employee willingness to adapt integration environment and the reduction of employee conflicts.

The second highest sub-barrier as per weight allocation within the category is a lack of awareness (PE-25) with a weight of 0.2435. The literature supports the idea that organizations need to deliver adequate IMS related training to their employees enabling the successful implementation of IMS (Wang, 2019). Therefore, an annual IMS training plan should be developed. Additionally, training sessions should provide awareness regarding the benefits of the integration of MSs and show how to implement and maintain the integration process.

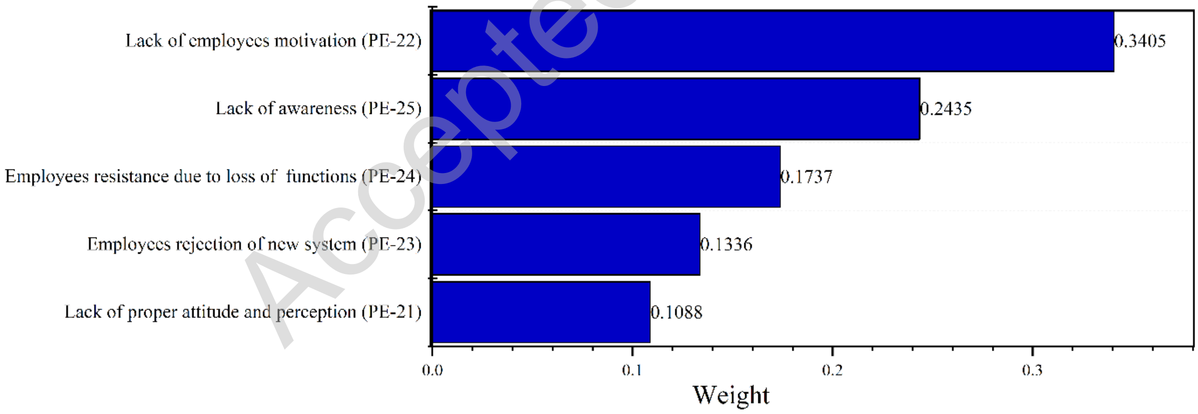

Fig. 5. *The ranking of People sub barriers*

Employee's resistance due to loss of individual functions (PE-24) has a weight of 0.1737 and is in the third position within the category. Companies that lack a formal long-term strategic plan can experience resistance and delays in the completion of the integration of their systems. Due to communication gaps between the top/middle management and employees of the aspects of the integration process, resistance can be expected within various management levels.

The fourth highest sub-barrier under the People category is the employee's rejection of a new system (PE-23) with a weight of 0.1336. It is common knowledge that nobody likes to change their old ways of doing things and implementing new systems or even updating existing procedures can involve substantial change. It can be both challenging and frustrating for people to communicate and explain their system requirements to others and explain how their systems may integrated with the other system(s). Last in this sub-barrier category, is lack of proper attitude and perception (PE-21) with a weight of 0.1088. People's attitudes are important to understand and assess, given that the behavior and the attitude of workers can negatively affect the successful implementation of the system.

Implementation: From the result presented in Fig. 6, the ranking of sub-barrier within implementation to implement IMS as follows IM-33>IM-34>IM-32>IM-31>IM-35 with a consistency ratio of 0.0223. Misunderstanding of integration concepts & lack of guidelines (IM-33) is at the first position within the implementation category by obtaining the highest weight of 0.3025. The proper guidelines and understanding the concept of integration is important for the implementation and maintenance of business processes based on top management commitment and their engagement to the implementation of IMS. Moreover, reduced flexibility after integration (IM-34) holds the second position within the category with a weight of 0.2482. The difference between (IM-31) and (IM-35) weights observed was 0.0071, which implies their almost equal contribution and importance in the implementation of IMS. To identify and analyze the factors that play an important role in implementation, companies adopt a systematic management approach that can create synergies and antagonisms between systems. The third and fourth sub barrier within the implementation for IMS is the different structure of individual MSS (IM-32) and the diversity of constituent MSS (IM-31) which received weights of 0.1662 and 0.1451 respectively.

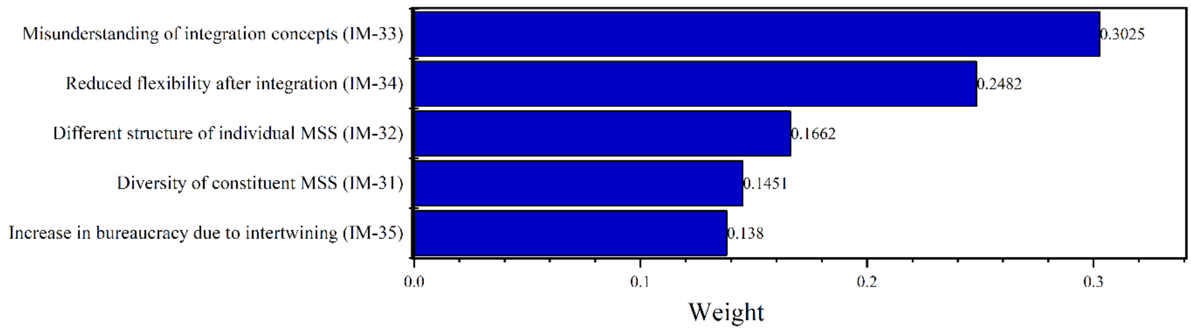

Fig 6. *The ranking of systematic management sub-criteria*

Top management should develop a structured approach to meet the need of stakeholders to create a balanced and effective allocation of resources within the company. Last in the sub-barrier within the category is an increase in bureaucracy due to intertwining (IM-35) with a weight of 0.1380. To effectively implement an IMS, we should also look at the Reduced Bureaucracy of management standards as they are very important for integrating management procedures, manuals, processes, authorizes, and responsibilities. The effective implementation of IMS needs to include the elimination of duplicate processes and the management of simplified documentation through merging techniques.

Economics: The ranking of this sub-barrier is as follows EC-41>EC-42. Insufficient drivers and benefits (EC-41) has a weight of 0.7606. Whereas, uncertainty about the value of IMS (EC-42) came second with a weight of 0.2394 represented in Fig. 7. Economic difficulties are related to the financial resources for IMS implementation. It is evident that IMS is involved in cost directly (through audit costs, training cost, certification costs etc.) and indirectly (through operational and social resources like building a team of expert personnel to monitor operations & processes, preventive measures for accidents, conformance to social and regulatory norms, etc.). IMSs are developed based on principal similarities of an organization’s management systems. However, it is difficult to standardize IMS with a single documented process due to the variety of organizational goals, tasks and characteristics, and the uncertainty of management, which is influenced by a rapidly changing economic and social environment.

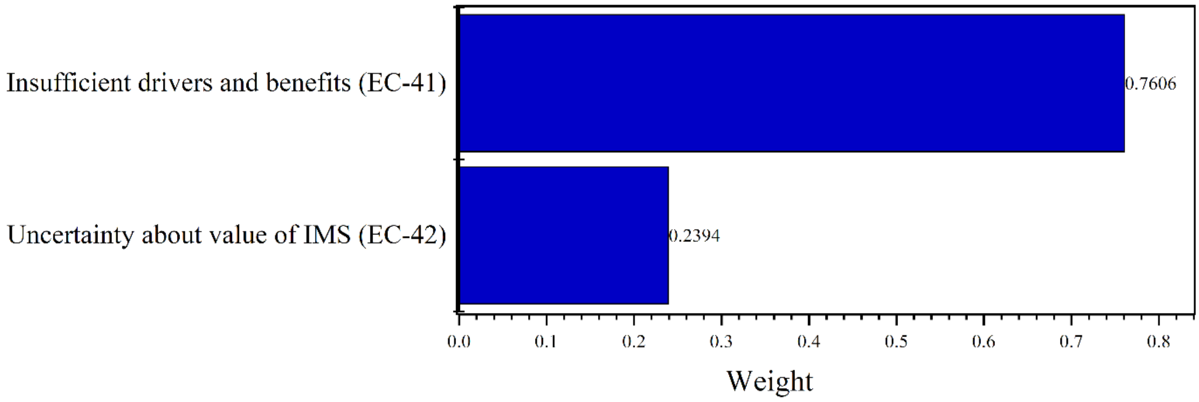

Fig. 7. *The ranking of Reduced Bureaucracy sub-criteria*

Social & Legal: From the result presented in Fig. 8, the ranking of sub-barriers within the social & legal category are as follows SL-54>SL-53>SL-52>SL-55>SL-51. The highest sub-barrier of social & legal is the unavailability of formal IMS (SL-54) with a weight of 0.3248. Until now, it has been reported in the literature that standards are designed purposely with a formal structure and allow integration of particular systems requirements into a general unified integrated management system (IMS). The ways of integration are, as previously mentioned, basically twofold; consecutive implementation of particular systems is then followed by the integration of IMS.

Continually changing regulations & guidelines (SL-53) ranks second with a weight of 0.2416. Whereas, varying demands from different stakeholders (SL-52) is in the third position with a weight of 0.1807. Due to the continually changing regulations, guidelines and different stakeholder demands, for instance in the environmental field, organizations are faced with the challenge of updating their procedures and systems. These changes consequently force the organizations to continually review their procedures, targets and objectives and update them accordingly.

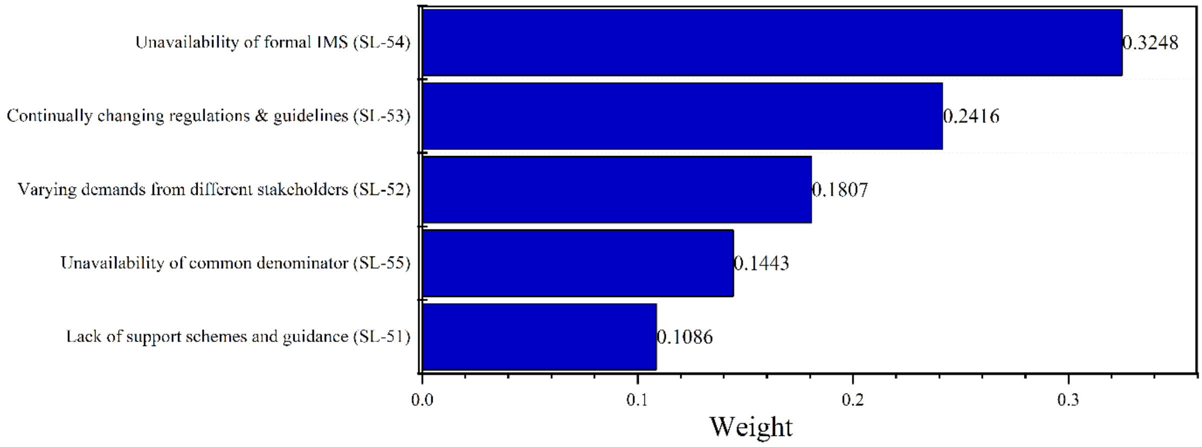

Fig. 8. *The ranking of Standardization sub-criteria*

Unavailability of common denominator (SL-55) and lack of support schemes and guidance (SL-51) came in fourth and fifth position with weights of 0.1443 and 0.1086, respectively.

Cultural: under the cultural category, the ranking of the sub-barriers is as follows CL-62>CL-61>CL-63. Lack of communication and team work (CL-62) obtained the highest weight and ranked most challenging sub-barrier within the category (0.5336) and is presented in Fig. 9. Organizational culture is an important pillar for the implementation of IMS, which motivates and stimulates the employees to create opportunities for improvements as well as effective system monitoring. The effective implementation of IMS required the leader to be personally involved in communicating the company's goals and plans and in motivating and rewarding the employees. The implementation of IMS provides facilities of creation, and sharing knowledge helps improve communication in an organization. This requires cultural transformation (CL-61) holds the second position within the category by obtaining a 0.2621 weight. Finally, varying culture and personality clashes (CL-63) is considered less influencing sub-criteria within the category by obtaining the weight 0.2044.

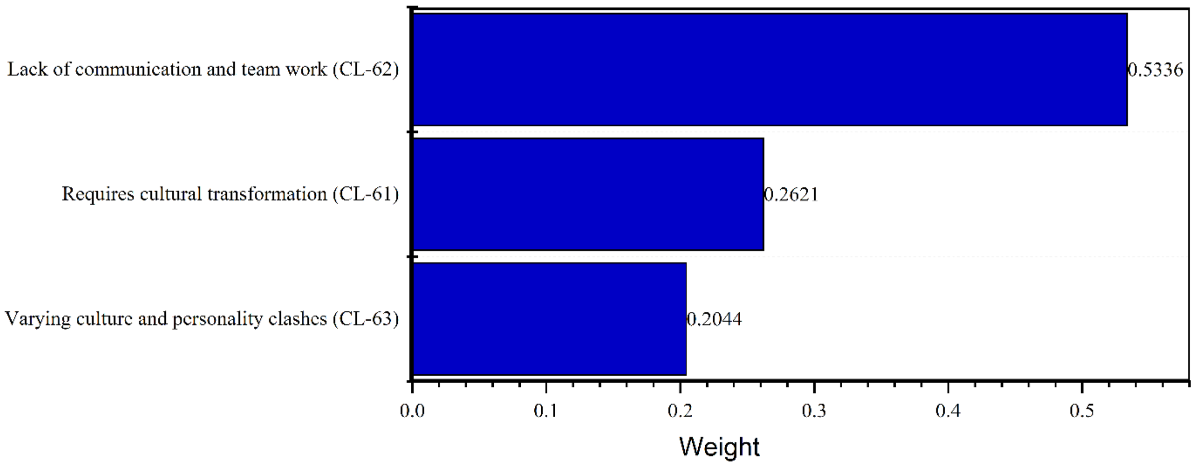

Fig. 9. *The ranking of organization learning sub-criteria*

To integrate management systems across departments it is crucial that personality clashes be avoided and people keep their egos in check. This requires managers and the employees working together for success.

4.2 Overall Ranking of sub criteria's

Calculating the final weight of sub barriers involves multiplying each sub-barrier's priority weight by the weight of its respective category. The final weights are in Table 7.

Table 7: Final weights of sub barriers

Main Criteria's	Main criteria weights	Sub criteria's codes	Consistency Ratio (CR)	Priority weight	Final weight
Resources and Management (RM1)	0.1735	RM-11	0.0146	0.2219	0.0406
		RM-12		0.0687	0.0126
		RM-13		0.2109	0.0366
		RM-14		0.2003	0.0386
		RM-15		0.1235	0.0226
		RM-16		0.1746	0.0319
People (PE2)	0.0602	PE-21	0.0040	0.1088	0.0099
		PE-22		0.3405	0.0311
		PE-23		0.1336	0.0122
		PE-24		0.1737	0.0158
		PE-25		0.2435	0.0222
Implementation (IM3)	0.3379	IM-31	0.0223	0.1451	0.0366
		IM-32		0.1662	0.0419
		IM-33		0.3025	0.0763
		IM-34		0.2482	0.0626
		IM-35		0.1380	0.0348
Economics (EC4)	0.0793	EC-41	0.0001	0.7606	0.0912
		EC-42		0.2394	0.0287
Social and Legal (SL5)	0.2326	SL-51	0.0109	0.1086	0.0236

		SL-52		0.1807	0.0393
		SL-53		0.2416	0.0525
		SL-54		0.3248	0.0706
		SL-55		0.1443	0.0314
Cultural (CL6)	0.1165	CL-61	0.0008	0.2621	0.0357
		CL-62		0.5336	0.0726
		CL-63		0.2044	0.0278

The overall ranking of sub barriers for the implementation of IMS based on final weights are presented in Fig. 10. The criteria of sub-barrier for IMS is as follows:

EC-41>IM-33>CL-62>SL-54>IM-34>SL-53>IM-32>RM-11>SL-52>RM-14>RM-13>IM-31>CL-61>IM-35>RM-16>SL-55>PE-22>EC-42>CL-63>SL-51>RM-15>PE-25>PE-24>RM-12>PE-23>PE-21

For the implementation of IMS, insufficient drivers and benefits is the barrier with the highest weight (9.12%) among all sub barriers followed by the misunderstanding of integration concepts & lack of guidelines (7.63%). Lack of communication and teamwork, and unavailability of formal IMS are the third and fourth most important sub barrier's by obtaining weights of (7.26%) and (7.06%) respectively. The last three less challenging sub barriers in the implementation of IMS are lack of information, expertise, and insufficient training (0.13%), employees' rejection of new system (0.12%) and lack of proper attitude and perception (0.09%) respectively.

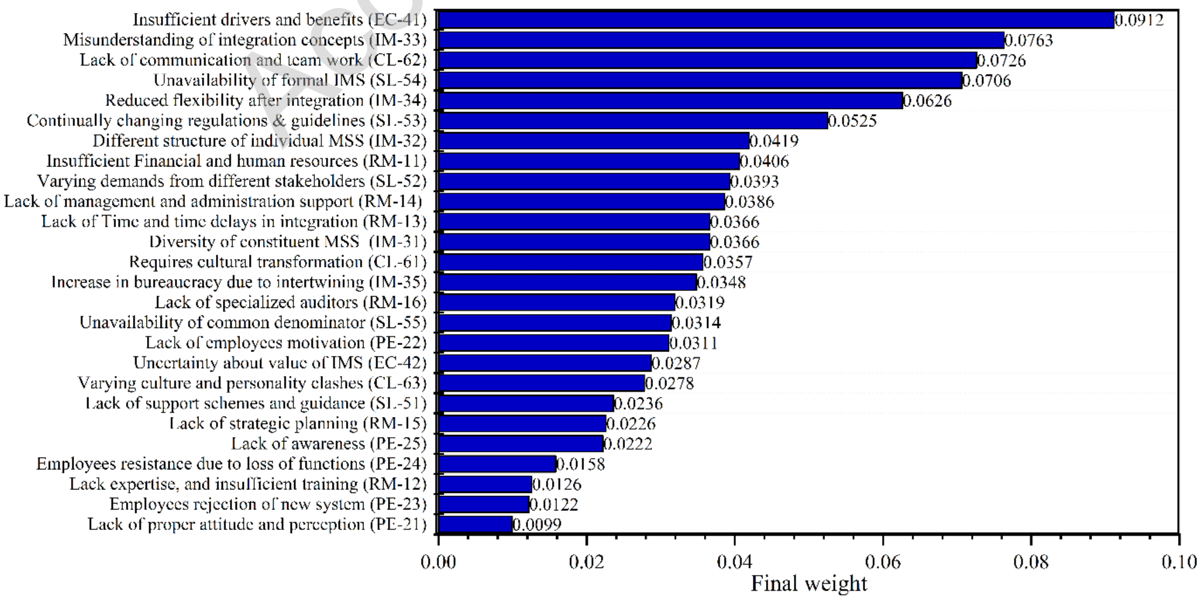

Fig. 10. *The overall ranking of sub-criteria*

4.1.3 Grey TOPSIS Result

We next employed AHP to calculate the weights of criteria and sub-criteria and set the rankings. In doing this, an important question arises, which alternative is important to help remove barriers during the implementation of IMS. In this section, the ranking of four main alternatives such as Integrated Audits (A1), Level of Integration (A2), Training & Development (A3), and Employee Motivation (A4) have been analyzed by employing Grey TOPSIS approach. A group of experts has helped to make this analysis, and we utilized the group decision-making approach to determine the results. The analysis by the group of experts established a grey evaluation matrix and grey number using linguistic variables. The linguistic variables rating matrix was obtained after the comparison of the alternatives against each sub-criterion. We considered the factors under the cost criteria (i.e., RM1, PE2, IM3) and benefit criteria (i.e., EC4, SL5, CL6), respectively.

Assigning the grey positive ideal solution and fuzzy negative ideal solution results are presented in Table 8. Finally, we calculated the possible degree of greyness between the alternatives and the ideal solutions. The Eqs. (19) to (22) represent the possible degree of greyness alternatives and the ideal solutions.

Table 8: Final ranking of alternatives based on Grey TOPSIS

Codes	Alternatives	S^{max}	S^{min}	possibility degree of greyness	Ranking
A1	Integrated Audits	0.351317	0.568604	0.618	4th
A2	Level of Integration	0.58266	0.290316	0.332	1st
A3	Training & Development	0.498722	0.408532	0.450	2nd
A4	Employee Motivation	0.329746	0.501852	0.603	3rd

$$A1(S_1 \leq S^{max}) = 0.618 \quad (19)$$
$$A2(S_2 \leq S^{max}) = 0.332 \quad (20)$$
$$A3(S_3 \leq S^{max}) = 0.450 \quad (21)$$
$$A4(S_4 \leq S^{max}) = 0.603 \quad (22)$$

Based on the values obtained by the possible degree of greyness, the ranking of the alternatives is presented in Eq. (23)

$$A_2 > A_3 > A_4 > A_1 \tag{23}$$

The methods Grey group TOPSIS results in Table 8 reveals that the level of integration and training & development the best solution for effective implementation of IMS by obtaining the weights (0.332) and (0.450) respectively. Employee motivation and integrated audits obtained almost the same weights (0.603) and (0.618) and the least influencing alternatives for implementation of IMS. Using Grey group TOPSIS increases the accuracy of the decision making in uncertainty conditions. Thus, the approach used in this study can help industries and policymakers in the selection of feasible solutions to proactively remove the barriers for effective implementation of an integrated management system across the organization.

4.1.4 Sensitivity Analysis

In this subsection, we performed a sensitivity analysis to check the robustness of the results. For example, when the weight of one criterion changes we want to look for a change in the other weights or to see if they remain constant as we investigate any influences on the final decision. Moreover, different weights can help the user to determine IMS priorities and making easier the evaluation process.

The new ranking of alternatives can be found in Figure 1. The original weight value is indicated by 'A', while 'W' represents the new weight value. There are other factors that can make expert feedbacks inconsistent, ultimately affecting the decision problem. In this regard, we performed the sensitivity analysis by changing expert feedbacks to check the difference in ranking obtained by Grey TOPSIS. For this reason, a new ranking of IMS alternatives was obtained based on new weights by changing the value of the degree of greyness, which plays a role in group decision making. The weight of W_2 (0.45124) and W_3 (0.336561) alternatives are changed, while the weight of W_1 (0.61630788) and W_4 (0.6014887) are constant. Based on the values obtained by five weight sensitivity analysis ranking of the alternatives is

$$A_3 > A_2 > A_4 > A_1$$

Based on the sensitivity analysis result is presented in Figure 11, it reveals that training & development and level of integration evaluated the optimal solution to overcome the barriers for effective implementation of IMS. Whereas, employee motivation and integrated audits obtained almost the same weights (0.6014887) and (0.61630788) and are considered to have the least influence of alternatives for implementation of IMS.

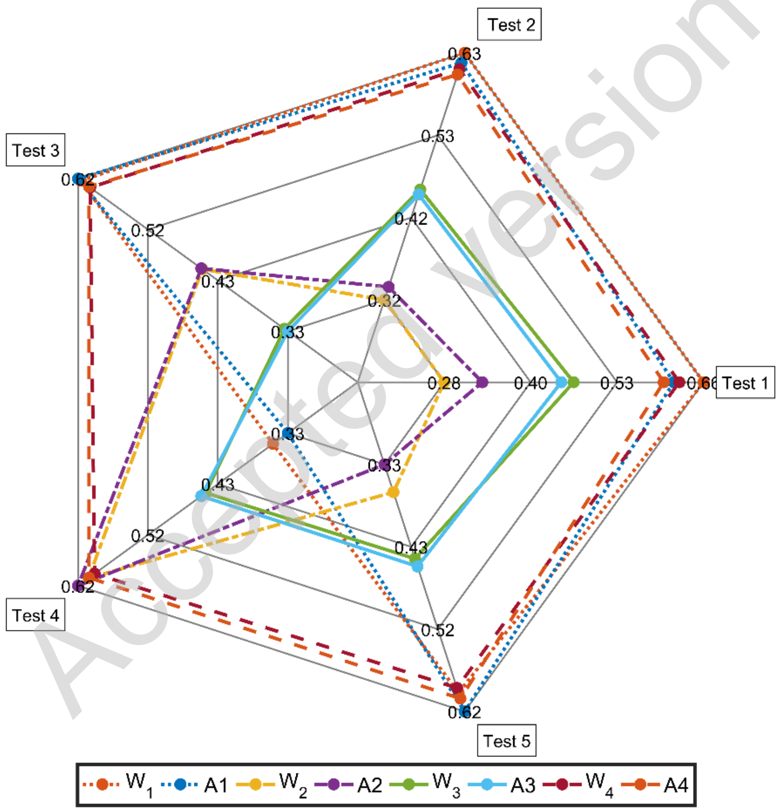

__Fig. 11.__ The final ranking of alternatives based on sensitivity analysis

4.3 Theoretical and Practical Implications

AHP is a problem-solving framework and a theory of measurement (Saaty, 1990). It is a decision analysis technique used to evaluate complex multi-attribute alternatives among one or more decision-makers. Since it allows the inclusion of subjective factors, it is considered as an advancement compared to other decision-making methods. AHP has attracted the attention of researchers in various fields because of its ability to provide support to decision-makers in a broad range of areas and industries. Areas of research over the past few decades include theoretical AHP developments, fuzzy approaches to decision-making and specific applications of AHP to support management activities including criteria for environmental and social sustainability (Emrouznejad and Marra, 2017). The use of AHP, and Grey TOPSIS methods in this study help to advance the integration of AHP with other multi-criteria methodologies to support traditional and now, more contemporary decision-making problems. The development of hybrid and modular methods is only increasing in importance. These evolving methods can be based on previously developed well-known methods, such as TOPSIS, SAW, DEA, AHP, ANP, VIKOR, DEMATEL, DEA, PROMETHEE, ELECTRE and their modification, by applying fuzzy and grey number theory will advance the field (Mardani, Jusoh, Nor, Khalifah, Zakwan, and Valipour, 2015). In order to help researchers and practitioners interested in hybrid MCDM techniques and approaches, it is necessary to publish more of these studies and literature reviews on these methods in future.

This study is not without limitations. Because the model was developed with the help of a Delphi group, there will be variance across the experts utilized in a study. Improvements can be made to modeling to help avoid this issue. In the future, an additional Delphi group can be used to refine and add more input to the model. With the addition of more practitioners, it would also help ensure the model and outputs are practical from a user's perspective. Another limitation is the availability of data to Delphi experts. An expert's perception of data availability can influence criterion importance. Resolving these issues is not easy. As the criterion are often qualitative in nature, and the values assigned to them can reflect belief structures of participants and social bias around some criterion. Although eliminating social bias altogether is difficult, there are methods to help minimize the effects of this potential source of bias.

As shown in this study, scholars can develop important criteria from the literature, build on this prior work while combining insight from experts in the field to now develop new insights, and help contribute to the development of theory with contemporary approaches to decision analysis. To this end, the results of this study provide insights other scholars can use to further develop theory involving multiple management standards (MMSs) along with integrated management systems (IMS), their implementation, barriers, and how to help ensure their success. The methods used in this study provide a powerful yet relatively simple method for making decisions. This approach can be used by both practitioners, policy makers, and researchers for resource allocation, project prioritization and selection. The methods used in this study allows for the capture of strategic goals as a set of weighted criteria that you then use to select projects and inform change management. Multi criterion decision making methodologies have been used successfully in various applications and industrial sectors. There should be more emphasis on interdisciplinary and social decision problems due to their complex nature. Future studies can and should be developed as AHP techniques are combined with other techniques and help integrate systems, supply chains, cities, and countries as we prioritize goals such as the United Nations seventeen sustainble development goals (SDGs).

5 Conclusions

Given the trends in MSS and IMS, successful firms can find a competitive advantage in the successful utilization of management systems. The growth of both the systems and accompanying standards leave decision-makers with questions as to what to do and when. The objective of this study is to identify and prioritized barriers based on the degree to which they hinder the effective implementation of an integrated management system. By understanding the barriers, decision-makers can better plan for and execute system implementation on a path toward integrated systems benefits. Numerous barriers were identified from the literature, which we refined with the help of experts. Our efforts provided twenty-six barriers within six main categories of Resources and Management, People, Implementation, Economic, Social and Legal and Cultural. In the study, the AHP method was then utilized for determining the six main barriers and 26 sub-criteria weights obtained from the various experts' through the pairwise comparison matrix. Further research in this area can consider a greater number of criteria while exploring other associated parameters and goals.

Contributions of this study start with the AHP results. They reveal Implementation, Social & Legal, and Resource Management as the top-ranked criteria, whereas, Insufficient drivers and benefits, Misunderstanding of integration concepts & Lack of guidelines, and Lack of communication and teamwork have emerged as the top-ranked sub-barrier of the study respectively. Additional insights and contributions to the field are extended with the additional application of a Grey group TOSPS method. This helped the researchers in this study to extend prior findings and to prioritize the four best alternatives to enhance and validate the consistency of the overall results. According to the results of the Grey group TOPSIS approach, Level of Integrations has been ranked as the most suitable solution to overcome the difficulties for the implementation of IMS, followed by training & development, employee motivation, and integrated audits.

The results of this study should be a call to action for scholars, decision-makers, business managers and policy advocates for effective implementation of IMS while carefully managing scarce resources. These systems can provide a dynamic opportunity for building on and extending prior benefits of quality management, including energy management and sustainable development while connecting business functions, supply chains and decision analytics with many benefits. Managerial implications include, but are not limited to IMSs enabling organizations to conduct integrated audits, assessments, and to optimize processes and resources. When managers integrate systems it can help reduce the time it takes to conduct transactions, perform activities, reduce interruption, while saving time and therefore reduce costs. The information uncovered in this study can help save time and improve impacts for practitioners while also providing the start to a new area of research from scholars. When systems become part of integrated management, they help to enable a proven strategic planning approach to uncover the tools and actions available for change management and performance metrics that can include sustainability (Sroufe, 2018). Future research calls for the integration of more systems as this integration trend is not going away. The methods employed in this study can inform future research on systems integration and implementation within enterprises, change management barriers and priorities, supply chain systems, smart cities, and help organize efforts to align systems with global sustainability goals, i.e., the UN SDGs.

The insights from our research are significant, and the first of its kind considering prioritizing the barriers to implementation of IMS. Proactive managers can now more quickly realize solutions resulting from managing company practices and the systems that measure, manage, and report on these activities. The results can be further refined and extended to explore other MCDM models and can be used in future work too to compare and contrast results, find new insights and extend this study.

Appendix-A

Table A1: List of experts

No.	Position	Qualification	Age	Department/Unit
1	Professor	PhD	45	NUAA, Nanjing
2	Associate Professor	PhD	40	USTC, Hefei
3	Director QEC	PhD	55	ECOCERT Group, Tianjin
4	General Manager QA	Graduation	48	Adidas, Guangzhou
5	Manager ESH	Graduation	42	Philips, Suzhou
6	Director Operation	Graduation	47	BVCPS, Shanghai
7	Deputy-Director	Graduation	53	BVCPS, Shanghai
8	Executive director	PhD	50	Alibaba Group, Nanjing
9	Senior Quality Officer	Graduation	43	Sustainability Department, Beijing
10	Head of Secure Management Systems & Professional Certification	Graduation	57	SGS, Beijing

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