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Volume 406

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Occupational and Environmental Safety and Health III

Springer

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ISSN 2198-4182 ISSN 2198-4190 (electronic)
Studies in Systems, Decision and Control
ISBN 978-3-030-89616-4 ISBN 978-3-030-89617-1 (eBook)
https://doi.org/10.1007/978-3-030-89617-1

A special tribute to Béda Barkokébas Júnior and Mohammad Shariari for their remarkable technical and scientific contributions over the years. We will always miss you.

Preface

Occupational and Environmental Safety and Health III is a compilation of the most recent work of some selected authors from 13 countries within the domain of occupational health, safety and ergonomics.

This book represents the state of the art, and it is mainly based on research carried out at universities and other research institutions, as well as some on-field interventions and case studies. Due to the broad scope, relevance and originality of the contributions, it is expected that this book contains useful and up-to-date information, and it presents fundamental scientific research that is being carried out in the subject, as well as it contributes to the outreach of practical tools and approaches currently used by OSH practitioners in a global context. All the included contributions were selected based on their potential to show the newest research and approaches, giving visibility to emerging issues and presenting new solutions in the field of occupational safety, health and ergonomics.

This book is based on selected contributions presented at the 17th edition of the International Symposium on Occupational Safety and Hygiene (SHO 2021), which was held on November 17–19, 2021, in Porto, Portugal.

All the contributions included in this book were previously peer-reviewed by, at least, two of the 112 members from 16 different countries of the International Scientific Committee of the 2021 edition. The event is organised annually by the Portuguese Society of Occupational Safety and Hygiene (SPOSHO).

Editors would like to take this opportunity to thank their academic partners, namely the School of Engineering of the University of Minho, the Faculty of Engineering of the University of Porto, the Faculty of Human Kinetics of the University of Lisbon, the Polytechnic University of Catalonia and the Technical University of Delft. The editors also would like to thank the scientific sponsorship of several academic and professional institutions, the official support of the Portuguese Authority for Working Conditions (ACT), as well as the valuable support of several companies and institutions. Finally, the editors wish also to thank all the reviewers, listed below,

who gave a critical contribution, without which it would not be possible to develop and publish the current book.

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The Role of the Quality Principles on the Integration of Multiple Management Systems

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Abstract The International Organisation for Standardization (ISO) established the Quality Management Principles (QMP) as the foundation values aiming at drive the performance improvement of management systems (MS). Since the QMP are transversal to any ISO standard, they also may support the integration of multiple MS (the IMS) and act as the basis for achieving a higher maturity level. The literature reviewed suggests an urgency in developing strategies to handle performance shortcomings of IMS and to facilitate organisations to achieve and operate on high performance levels. Intending to contribute to this matter, the goals of this paper embrace to establish the specific common requirements (SR) amidst ISO 9001, ISO 14001 and ISO 45001 standards, and to determine the quantitative efficiency of the QMP for the requirements integration. The data collection was carried out via an online survey, which was designed to be answered by representative experts in the MS and IMS field, and through literature review. Supported on the data collected, the pivotal QMP and the correlated SR were established and their scores: metrics to treat more efficiently the detected non-conformities (i.e. the shortcomings of the integration performance). Further, the results comprise the disclosure of the significant role of the QMP 'Process Approach' (in addition to the 'Leadership') for the integration. Therefore, the QMP efficiency scores might be adopted as a strategy by any organisation holding an IMS, to efficiently handle the performance limitations.

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P. M. Arezes et al. (eds.), *Occupational and Environmental Safety and Health III*,
Studies in Systems, Decision and Control 406,
https://doi.org/10.1007/978-3-030-89617-1_53

Keywords Environment · Health and safety · Integrated management systems · Quality · Performance measurement

1 Introduction

Pursuing to effectively create customer value, in recent years, organisations have implemented the certified Quality Management System (QMS), the Environmental MS (EMS) and the Occupational Health and Safety MS (OHSMS) according to the ISO's standards: an inevitable circumstance for integration. The ISO 9001 standard specifies requirements for implementing a QMS and points out their potential benefits to the organisation, such as the improvement of overall performance, the fulfilment of the customers' requirements (by foreseeing their future needs and expectations), altogether culminating on enhancement of the customer satisfaction. Seven Quality Management Principles (QMP) were established as the basis of the ISO 9001 for a QMS: Customer focus, Leadership, Engagement of People, Process Approach, Improvement, Evidence-based Decision Making and Relationship Management. According to the ISO, these principles are the foundation values to drive performance improvement and organisational excellence (ISO - Quality Management Principles 2015a), i.e., a "fundamental rule" for continuously improve performance focussing on the long term (Dordević 2018, p. 35). Furthermore, the principles act as the pillars of excellence management and are common features in any ISO standard that may comprise an IMS (Integrated Management System) (Domingues 2013) therefore, might be the basis for the integration of other MS (Sampaio et al. 2012).

Zeng et al. (2011) posit that "the objective of the IMS is to achieve continuous improvements" (p. 184) thus, the adoption of the QMP might feed a purpose synergy for the IMS whilst the QMS adoption might be the first step on this pursuit for continuous improvement. However, the MS certification according to the ISO standards does not assure undoubtedly the establishment of continual improvement practices, culture and organisational climate, and improved performance (Boiral 2008; Dordević 2018). The organisation's awareness for continuous improvement, clarity of purpose and directness that will determine the release of the substantive results according to the propositions embedded in the standards' requirements. It is an organisation role to assure the directives are not merely procedures to be addressed as well the presence of a motivation to reach added value to the organisation' outcomes. According to Boiral (2008) the gains are a corollary in which manner the standards are implemented and the extent of consistency of the policies adopted than on whether or not one is certified.

The ISO standards share a same structural pattern, i.e., the ISO high-structure level (Annex SL (normative) n.d.) which is in turn coupled with the PDCA (Plan-Do-Check-Act) cycle. These attributes provide compatibility between the standards and turn them well suited for integration. Beyond these common features, the ISO domain can present other kind of similarities that may facilitate the integration and can be interpreted as capabilities beyond the common implementation factors (Tarí

and Molina-Azorí-n 2010). Furthermore, Sampaio et al. (2012) reported a high compatibility between the EMS and OHSMS standards in the surveyed companies.

Based on the above mentioned, this paper aims to address the contribution of each QMP for the integration and performance of an IMS. For that, main objectives were outlined: (i) ascertaining the most integrable MS' requirements among ISO 9001 (ISO 2015b), ISO 14001 (ISO 2015c) and ISO 45001 (ISO 2018) standards (i.e., the synergistic requirements); (ii) determining the quantitative efficiency of the QMP for the requirements integration (i.e., the QMP efficiency scores).

2 Materials and Methods

This topic presents the methodological strategy selected and performed to collect data and achieving the objectives of this study. The survey is a quantitative research strategy and questionnaires a structured approach of extracting reliable information (Saunders et al. 2009). Thus, the quantitative data was collected via an online survey through the development of a questionnaire, which was designed for leadership professionals, industrial and academic experts that are representative in the MS and IMS field. It is also important to highlight that an exploratory and comprehensive literature review was carried out in order to map the relevant literature and getting a deep understanding of the subject.

The questionnaire development was oriented for correlating the synergistic aspects (the SR) of the ISOs for QMS (9001:2015), EMS (14001:2015) and OHSMS (45001:2018) with the QMPs, whereby the experts should rank each QMP according to levels of relevance. Hence, aiming to achieve the objectives of this paper several steps were performed: (i) the identification of the most integrable requirements (the SR) between the three mentioned standards and through a transversal analysis, and (ii) the selection of the key ones; (iii) the SR's contextualisation, mandatory to draw up the questions-statements. The questionnaire holds nine questions and the QMP presented as sub-questions for each one. The experts should deliberate about the information offered in the statements and then rate each QMP in a scale of 'not relevant', 'relevant' or 'totally relevant'.

It was intended to capture from the respondents the sense of adoption and implementation of the requirements in an integrated approach in the businesses, further, the experts could infer around the application of the QMP and measure their relevance in the exposed circumstances. The choice of the measure scale (three points) aims at a more precise answer about relying on QMP as guiding principles and, if so, to evaluate whether it would be relevant or mandatory for the requirements integration. Furthermore, it was expected that respondents, as skilled specialists, would be able to access their experiences, recall past actions and behaviours, judge the questions, and make decisions based on those experiences. They were also expected to be motivated in benchmarking their own knowledge moreover, contributing to the state of the art regarding the topic.

The diagrams and statistical analysis were supported by the IBM Statistical Package for the Social Science (SPSS) version 27 and the Microsoft Excel. Therefore, to enable an exploratory statistical analysis of the survey results in SPSS, a variable transformation of the answers was executed aiming to recode the qualitative relevance scale (i.e., the questionnaire measure scale) into quantitative data as following: 'not relevant' = value 1; 'relevant' = value 2; 'totally relevant' = value 3.

3 Results

As part of the results obtained, the specific common requirements, or SR, between ISO 9001, 14001 and 45001 are established and described hereinafter:

- SR1 Scope and Boundaries – 4.3 Determining the scope of the QMS/EMS/OHSMS;
- SR2 Leadership – 5.1 Leadership and commitment; 5.2 Policy; 5.3 Organizational roles, responsibilities, and authorities;
- SR3 Interested Parties – 4.2 Understanding the needs and expectations;
- SR4 Management of changes, risks and opportunities – 6.1 Actions to address risks and opportunities;
- SR5 Documented Information Control – 7.5 Documented information;
- SR6 Strategic Direction, Strategic Objectives and Policy – 5.2 Policy; 6.2 QMS/EMS/OHSMS objectives and planning to achieve them;
- SR7 Performance Measurement System – 9.1 Monitoring measurement, analysis, and evaluation;
- SR8 Internal Audit – 9.2 Internal audit;
- SR9 PDCA Cycle and Continual Improvement – 0.4 PDCA and 0.3.2 PDCA (this last in ISO 9001); 10.3 Continual improvement.

Concerning the survey, a total amount of 55 experts were chosen to participate on the online survey and selected as beacons in the subject under study. This set of individuals was contacted and 13 agreed to take part. Hence, 13 valid answers were collected, a response rate of approximately 24%. The respondents are located in three continents and in nine different countries namely Brazil, Denmark, Ghana, Macedonia, Portugal, Romania, Spain, Sweden, and Switzerland; diversity, that in addition with their expertise, enriches the knowledge that is the foundation of this study. Altogether, they account for 365 years of experience (199 in academia; 166 in industrial context, considering them as distinct types of experience) in the MS or IMS field. A proportion of 62% (eight experts) holds both academic and industrial experience and 62% holds more than 20 years of experience in at least one of these fields.

The next step focused on the exploratory statistical analysis of the survey results. The experts' answers for the Question 9, i.e. SR 9, are graphically presented (as an example) in Fig. 1. The boxplots depict quantitatively the relevance ascribed by the respondents for every QMP. By adopting this type of chart is possible to establish a

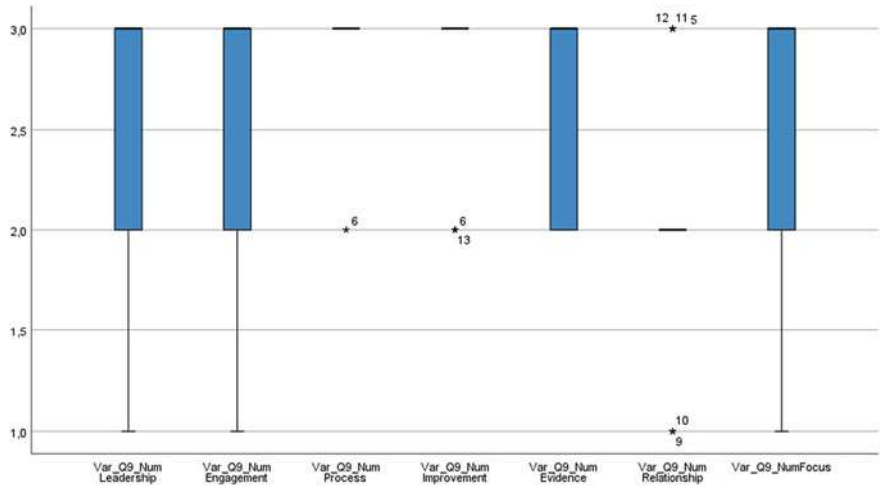

Fig. 1 Results from Question 9

comparison between the several data sets, and inferring about their distribution, such as: identifying the degree of dispersion and concentration of the data, the extreme values (outliers) and how far they are from the most of the data. It is possible to observe that there is a strong concentration of responses since the interquartile ranges not always can be well distinguished. Taking into account the shape of the boxplots, there are quartiles coincident and overlapped. Therefore, it is reasonable to affirm the data are mostly concentrated on the highest value of the relevance scale, on the response 'totally relevant' (value 3). It is also possible to characterize the data sets as asymmetrically distributed and skewed left (so, the median, on this case, will be the proper and more robust measure). This negative asymmetry asserts the low dispersion of the data and, therefore, a high consensus among respondents.

However, despite the high consensus among the respondents, it is possible to observe the presence of outliers meaning there are answers outside the predominant pattern. By analysing the experts' answers for all questions, a similar data pattern described was observed.

Based on the outcomes of the survey, a hierarchical analysis holding a set of criteria was developed to establish a ranking and relative weights/priorities to be ascertained for each QMP (correlated to each SR). The descriptive statistics, the boxplots and the dendrogram (used to verify the proximity between the set of QMP so, as a measure of relevance) were the metrics and source of information chosen so that the hierarchy criteria were underlined. For example, the SR 9, i.e., Question 9, presented the QMP 'Process approach' with the highest score values of median (the median is the central tendency measure, thus, the most robust for asymmetric distributions), sum, and frequency (i.e., number of times the QMP was evaluated as 'Totally relevant'). Hence, on the hierarchical criteria, the QMP 'Process approach' was defined as the most relevant QMP for the successful implementation and integration of the

requirements 0.4/0.3.2 Plan-Do-Check-Act cycle and 10.3 Continual improvement, followed by 'Leadership' and 'Engagement of people'. This hierarchical process was adopted for every QMP and each SR.

The next step embraced ascribing quantitative weights (scores) to each QMP. These weights were calculated based on their ranking and according to Eqs. 1 and 2:

$$w1 > w2 > ...w7 \,|\, w1 = 7;\ w2 = 6;\ ...w7 = 1 \tag{1}$$

$$Ws = wp, s \cdot Fp, s \tag{2}$$

where: Ws: weight of the QMP. s: the related SR. wp, s: is the weighting coefficient based on the QMP ranking; it can assume values [1 – 7] (Eq. 1) p : position ranking based on the hierarchical criteria. Fp, s: is the frequency of the 'totally relevant' response (value 3).

Table 1 displays the weights (i.e., the efficiency scores) of the QMPs that assume the first three positions on the relevance ranking, by each SR.

4 Discussion

The concentration of data responses on the highest value of the relevance scale ('totally relevant') and, so far, ascribed by the beacons in the field, corroborates the pivotal role of the QMP for the integration process. Furthermore, that is an evidence of the importance of adopting this set of principles as a strategy for evaluating an IMS.

Table 1 provides the QMP that hold the greatest impact, upon specific common requirements, the SR, whereby it is possible to observe that 'Leadership' owns a pivotal role once is the one that most assumes the first position (four times), followed by 'Process Approach' (three times). Hence, these two QMP, together, hold 78% of relevance for the integration whilst the others QMP hold 22% (Pareto principle).

The IMS audit reports register non-conformities and reveal the shortcomings around the capability of IMS operation and requirements implementation. Now, since the pivotal QMP and the correlated SR are established (and the scores of their contribution), the detected non-conformities (i.e., limitations in terms of performance) can be better managed which constitutes a shift for handling improvement opportunities. Therefore, Table 1 might be considered as a road map for that, which holds non-conformities as input into a cause-and-effect relation with the QMP (Fig. 2).

Furthermore, the requirement's scopes of PDCA Cycle and Continual Improvement; Internal Audit; Performance Measurement System; Strategy, Objectives and Policy; Documented Information; Risk Based-thinking; Interested Parties; Leadership, and Scope and Boundaries were established and validated by the experts as the key ones whose are common to the ISO 9001, 14001 and 45001 standards. They

Table 1 The QMP ranking (position) and their efficiency scores assigned, by each SR

SR1_SCOPE and BOUNDARIES	Ranking	Weight	Score
(L) Leadership	1[a]	7,00	30,60 %
(CF) Customer focus	2[a]	5,08	22,20%
(EP) Engagement of people	3[a]	4,23	18,40%
SR2_LEADERSHIP	Ranking	Weight	Score
(L) Leadership	1[a]	6,46	31,11%
(EP) Engagement of people	2[a]	5,08	24,44%
(IM) Improvement	3[a]	3,08	14,80%
SR3_INTERESTED PARTIES	Ranking	Weight	Score
(CF) Customer focus	1[a]	6,46	36,05%
(RM) Relationship management	2[a]	4,61	25,75%
(EP) Engagement of people	3[a]	2,69	15,00%
SR4_RISK BASED-THINKING	Ranking	Weight	Score
(L) Leadership	1[a]	5,38	25,92%
(IM) Improvement	2[a]	4,61	22,21%
Evidence-based decision making	3[a]	3,85	18,51%
SR5_DOCUMENTED INFORMATION	Ranking	Weight	Score
(PA) Process approach	1[a]	5,92	35,95%
(ED) Evidence-based decision making	2[a]	5,08	30,81%
(EP) Engagement of people	3[a]	1,93	11,70%
SR6_STRATEGY, OBJECTIVES and POLICY	Ranking	Weight	Score
(L) Leadership	1[a]	6,46	33,90%
(EP) Engagement of people	2[a]	4,61	24,18%
(CF) Customer focus	3[a]	3,08	16,12%
SR7_PERFORMANCE MEASUREMENT SYSTEM	Ranking	Weight	Score
(PA) Process approach	1[a]	6,46	30,10%
(ED) Evidence-based decision making	2[a]	5,54	25,80%
(IM) Improvement	3[a]	3,85	17,91%
SR8_INTERNAL AUDIT	Ranking	Weight	Score
(EP) Engagement of people	1[a]	5,92	30,56%
(PA) Process approach	2[a]	5,08	26,20%
(IM) Improvement	3[a]	3,08	15,86%
SR9_PDCA and CONTINUAL IMPROVEMENT	Ranking	Weight	Score
(PA) Process approach	1[a]	6,46	31,35%
(IM) Improvement	2[a]	5,08	24,65%
(ED) Evidence-based decision making	3[a]	3,46	16,78%

Ranking Matrix

SR 1	SR2	SR3	SR4	SR5	SR6	SR7	SR8	SR9
L	L	CF	L	PA	L	PA	EP	PA
CF	EP	RM	IM	ED	EP	ED	PA	IM
EP	IM	EP	ED	EP	CF	IM	IM	ED

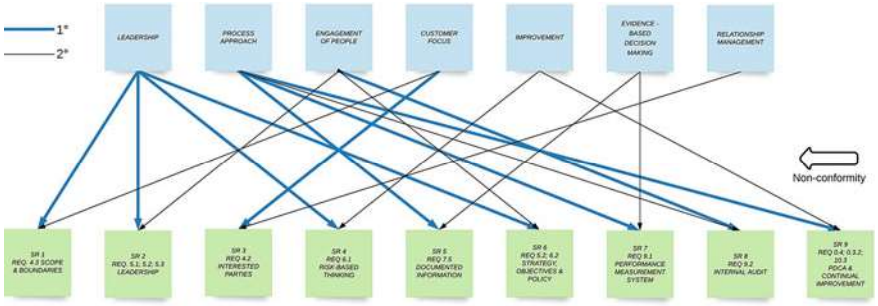

Fig. 2 The cause-and-effect relation between the requirements integration and the QMP

might be the standards' references for integration that can be used by organisations as a starting point.

Research Limitations The online survey was conducted among a limited sample of leadership professionals, industrial and academic experts which may have restricted the results obtained. It arises as an opportunity for future research, in terms of conducting a new survey among a broader number of experts and thus, for analysing whether the QMP efficiency scores are sustained.

5 Conclusions

The correlation between the QMP with the defined SR was established quantitatively. Since the QMP are transversal to the three ISO standards, the supportive role of these pillars goes beyond just over the standards: they support the operation and maturity of an IMS. In practice, these weights represent quantitatively the contribution of the QMP for the IMS performance and its efficiency therefore, the score of their contribution throughout the integration process. Another distinctive contribution of this project is the disclosure of the potentially significant role of the 'Process Approach' QMP for the requirements integration (added to the pivotal role of the 'Leadership' already pointed out by the mainstream literature). The QMP efficiency scores is a strategy idealised to be employed as an independent tool, by any organisation, to efficiently handle performance deficiencies of its IMS.

Accordingly, to Wiengarten et al. (2018) the technical efficiency pursuit by organisations figures among the expectations on adopting an ISO standard, moreover, the increasing pressure for organisations beckoning the compliance concerning OHS and environmental constraints (while assuring a minimum level) can be a powerful driver towards certification. In this sense, it is essential that an organisation gets a holistic perspective of its organisational processes' capabilities and maturity therefore, identifying opportunities for change, for prioritising investments and targeting

efforts meant for continuous improvement (Asah-Kissiedu 2019; Dragomir et al. 2017). The literature reviewed also suggested an urgency in improving strategies to diagnose and to improve capabilities, thus, to facilitate organisations to achieve and operate on high performance levels.

Acknowledgements Acknowledgements are due to all the respondents who kindly answered the survey.

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