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Occupational and Environmental Safety and Health III

 Springer

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*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,

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Contents

Occupational and Environmental Safety

Cultural and Technical Adaptation of <i>SafetyCard</i> to the Brazilian Legislative and Organizational Context	3
Hernâni Veloso Neto, Pedro M. Arezes, and Béda Barkokébas Junior	
SWS—A Decision-Making Tool to Support Occupational Safety	13
Ana Rita Ferreira, Ângelo Soares, Bruno Sousa, Marlene Brito, Maria A. Gonçalves, Luís P. Ferreira, and Francisco J. G. Silva	
Analysis of Occupational Accidents in Greek Construction Sector—the Use of Deviation in Accident Reports	25
Panagiota Katsakiori, Eva A. Sgourou, and Ioanna Konsta	
Towards the Application of a Simplified Approach for OSH Risk Assessment Through a User-Friendly and Expedite Computational Tool	41
Pedro D. Gaspar, Joel Alves, and Tânia M. Lima	
Analysis of Safety Culture Maturity in Two Finnish Companies	53
Julius Pirhonena, Sari Tappura, and Aki Jääskeläinen	
Prevention of Occupational Risks in a Construction Site Using BIM	63
Manuel Tender and João Pedro Couto	
Improving Occupational Health and Safety Data Integration Using Building Information Modelling	75
Manuel Tender, João Pedro Couto, and Paul Fuller	
Integrating Occupational Health and Safety Data Digitally Using Building Information Modelling—Uses of BIM for OHS Management	85
Manuel Tender, João Pedro Couto, and Paul Fuller	

Achieving a Safer Construction Environment with BIM for Safety Framework	97
Adeeb Sidani, João Poças Martins, and Alfredo Soeiro	
New Approaches of Near-Miss Management in Industry: A Systematic Review	109
Maria Helena Pedrosa, J. C. Guedes, Isabel Dias, and Ana Salazar	
Occupational Risks Identification in the Red Ceramics Manufacturing Process	121
Antonia Monaliza Soares Lopes, Marília Bezerra Tenório Cavalcanti, Felipe Mendes da Cruz, Bianca Maria Vasconcelos, Tomi Zlatar, and Eliane Maria Gorga Lago	
Risk Assessment at the Connection from Mondim de Basto to EN210 ...	131
F. S. Meretti, C. M. Reis, J. J. F. Baptista, L. F. S. Fernandes, and C. Oliveira	
Occupational and Environmental Hygiene	
Analysis of Whole-Body Vibration Transmitted in Ready Mix Concrete Delivery Operations	145
María L. de la Hoz-Torres, Antonio J. Aguilar, Diego P. Ruiz, and M. D. Martínez-Aires	
Occupational Exposure to Noise in the Extractive Industry and Earthworks—Short Review	155
J. Duarte, J. Castelo Branco, Fernanda Rodrigues, and J. Santos Baptista	
Occupational Exposure to Bioburden in Portuguese Ambulances	167
Marta Dias, Pedro Sousa, and Carla Viegas	
Occupational and Environmental Health	
Long-Term Driving Causes Gait Plantar Pressure Alterations in Subjects Groups	177
Marko M. Cvetkovic, J. Santos Baptista, and Denise Soares	
Solutions Aiming a More Reliable Fungal Burden Risk Characterization	187
Carla Viegas	
Differences in Sleep Quality and Sleepiness Between 2017 and 2019 Among Workers from the Water, Sanitation and Waste Sector	197
Ana Dionísio and Teresa Cotrim	

Prevalence of Musculoskeletal Symptoms Among Portuguese Call Center Operators: Associations with Gender, Body Mass Index and Hours of Work	207
I. Moreira-Silva, Raquel Queirós, Adérito Seixas, Ricardo Cardoso, Nuno Ventura, and Joana Azevedo	
Musculoskeletal Injuries and Associated Pain in Portuguese Ju Jitsu Athletes: Prevalence and Associated Factors	215
Tiago Rodrigues, Joana Azevedo, Isabel Silva, Ricardo Cardoso, Nuno Ventura, Sandra Rodrigues, and Adérito Seixas	
An Overview of the Development and Implementation of the Radon Action Plans in European Countries	225
Ana Sofia Silva and Maria de Lurdes Dinis	
Cortisol as a Biomarker of Work-Related Stress in Firefighters: A Systematic Review	237
Tatiana Teixeira, J. Santos Baptista, D. Bustos, and J. C. Guedes	
Medium and Long-Term Assessment of Fatigue Based on Workload and Rest-Activity Cycle	249
E. A. Stradioto Neto, D. Bustos, and J. C. Guedes	
Assessment of Fatigue Based on Workload and Rest Activity Cycles—A Pilot Study	261
E. A. Stradioto Neto, D. Bustos, and J. C. Guedes	
Energy, Thermal Comfort and Pathologies—A Current Concern	273
Inês Teixeira, Néilson Rodrigues, and Senhorinha Teixeira	
Variables Influencing Heat Stress Response in Humans: A Review on Physical, Clothing, Acclimation and Health Factors	281
Tomi Zlatař, Teerayut Sa-ngiamsak, and Gercica Macêdo	
Physiological Monitoring Systems for Firefighters (A Short Review)	293
D. Bustos, J. C. Guedes, J. Santos Baptista, Mário Vaz, J. Torres Costa, and R. J. Fernandes	
Fatigue Assessment Through Physiological Monitoring During March-Run Series: Preliminary Results	307
D. Bustos, J. C. Guedes, Mário Vaz, J. Torres Costa, R. J. Fernandes, and J. Santos Baptista	
Insight into the Potential of Urinary Biomarkers of Oxidative Stress for Firefighters' Health Surveillance	321
Bela Barros, Marta Oliveira, and Simone Morais	

Prevalence of Patellofemoral Pain Syndrome in Selective Garbage Collection Workers—Cross Sectional Study	337
Pablo M. Pereira, J. Amaro, J. Duarte, J. Santos Baptista, and J. Torres Costa	
Indoor Air Quality Under Restricted Ventilation and Occupancy Scenarios with Focus on Particulate Matter: A Case Study of Fitness Centre	345
Klara Slezakova, Cátia Peixoto, Maria do Carmo Pereira, and Simone Morais	
Ergonomics and Biomechanics	
Patellofemoral Pain Syndrome Risk Factors Analysis in Selective Garbage Truck Drivers	357
Pablo Monteiro Pereira, J. Duarte, J. Santos Baptista, and J. Torres Costa	
Simulating Human-Robot Collaboration for Improving Ergonomics and Productivity in an Assembly Workstation: A Case Study	369
Guilherme Deola Borges, Diego Luiz de Mattos, André Cardoso, Hatice Gonçalves, Ana Pombeiro, Ana Colim, Paula Carneiro, and Pedro M. Arezes	
Musculoskeletal Disorders Investigation Among Workers that Operate with Brush Cutter in Vegetal Maintenance Tasks	379
Filipa Carvalho, Teresa Cotrim, and Rui B. Melo	
Application of ErgoVSM to Improve Performance and Occupational Health and Safety Conditions in a Medication Dispensing System	389
Igor André Gonzatti Feldman and Angela Weber Righi	
How Ergonomic Evaluations Influence the Risk of Musculoskeletal Disorders in the Industrial Context? A Brief Literature Review	399
A. Pimparel, S. Madaleno, C. Ollay, and A. T. Gabriel	
Ergonomic Assessment on a Twisting Workstation in a Textile Industry	411
José Barbosa, Paula Carneiro, and Ana Colim	
Evaluation of Ergonomic Risk of Warehouse Activities in a Telecommunications Sector Company	421
J. Fernandes, R. Monteiro, Paula Carneiro, Ana Colim, and L. Loureiro	
Ergonomic Study of a Support Interface for the Therapheet Device in the Rehabilitation of the Tibiotarsal Joint	433
Ana Colim, Ana Pereira, Eurico Seabra, Maria Rodrigues, and Rui Viana	

WIDEA: Waste Identification Diagram with Ergonomic Assessment—Towards the Integration of Lean and Ergonomics	443
A. C. Peixoto, J. Dinis-Carvalho, Ana Colim, N. Sousa, L. A. Rocha, and João Oliveira	
Assessment of Work-Related Musculoskeletal Disorders by Observational Methods in Repetitive Tasks—A Systematic Review	455
Hatice Gonçalves, André Cardoso, Diego Mattos, Guilherme Deola Borges, Paulo Anacleto, Ana Colim, Paula Carneiro, and Pedro M. Arezes	
Ergonomics and Safety in the Design of Industrial Collaborative Robotics	465
Sofia Pinheiro, Ana Correia Simões, Ana Pinto, Bram Boris Van Acker, Klaas Bombeke, David Romero, Mário Vaz, and Joana Santos	
Aworkstation Assessment Tool Considering Ergonomics Aspects (WATEA)	479
Alfredo Silva, Ana Luísa Ramos, Marlene Brito, and António Ramos	
Occupational Psychosociology and Human Factors	
Work Passion and Workaholism: Consequences on Burnout of Health and Non-Health Professionals	493
Joana Santos, Cátia Sousa, Gabriela Gonçalves, and António Sousa	
Occupational Stress and Cognitive Appraisal Profiles as Predictors of Students' Burnout	505
A. Rui Gomes, Clara Simões, Catarina Morais, and Adriana Couto	
Psychosocial Working Climate in a Portuguese Metallurgical Industry	521
Estela Vilhena, Delfina Ramos, Hernâni Veloso Neto, and Carla Vilaça	
Safety Climate Perception Among Students: A Literature Review	533
Vinicius Cozadi de Souza and Rui B. Melo	
Anxiety, Depression and Stress Among University Students: The Mediator Role of Work in Time of COVID-19	545
C. Barros, A. Sacau-Fontenla, and C. Fonte	
Functional Capacity Profiles Adjusted to the Age and Work Conditions in Automotive Industry	555
Sarah Bernardes, Ana Assunção, Carlos Fужão, and Filomena Carnide	

Other Occupational and Environmental Issues

Environmental Determinants of Home Accident Risk Among the Elderly. A Systematic Review	571
Tuíra Maia and Laura Martins	
Impacts of Nonstandard Work Schedules on Family and Social Life: The Children’s Perspective	579
Daniela Costa and Isabel S. Silva	
The Challenges of Automated Driving Contributions Towards a Human-Automation Research Agenda from the Lens of the Activity	591
Daniel Silva and Liliana Cunha	
The Role of the Quality Principles on the Integration of Multiple Management Systems	603
Carolina Ferradaz, Pedro Domingues, Paulo Sampaio, and Pedro M. Arezes	
Occupational Health and Safety in the Brazilian Sector of Cargo Transportation: A Systematic Review on the Category of Self-Employed Drivers	613
R. Soliani and L. Bueno	
A Short Review on the Usage of Online Surveys Among Health Professionals	621
D. Bustos, T. Teixeira, J. C. Guedes, J. Santos Baptista, and Mário Vaz	
Mask Use During the COVID-19 Pandemic: A Study with Civil Servants of Education	635
Pedro Cândia Neto and Nívia de Araújo Lopes	
Workers’ Lifestyle, Occupational Workload and Their Relation to Work Fatigue: A Short Review	645
Ana Sophia Rosado, J. Santos Baptista, and J. C. Guedes	
Sleep Quality and Quality of Working Life Among Brazilian University Professors in Telework	661
Tânia Crepaldi, José Carvalhais, and Teresa Cotrim	

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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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603

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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-Azorín (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

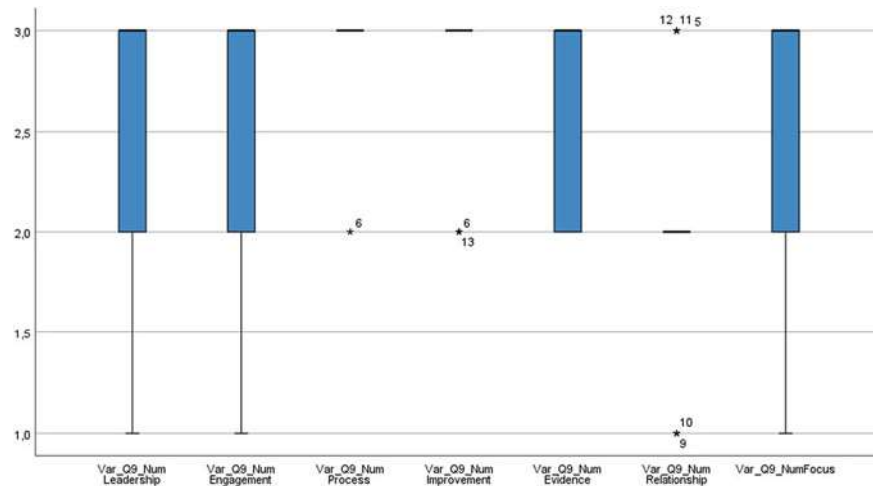


Fig. 1 Results from Question 9

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:

$$w_1 > w_2 > \dots w_7 \mid w_1 = 7; w_2 = 6; \dots w_7 = 1 \quad (1)$$

$$W_s = w_{p,s} \cdot F_{p,s} \quad (2)$$

where: W_s : weight of the QMP. s : the related SR. $w_{p,s}$: 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. $F_{p,s}$: 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

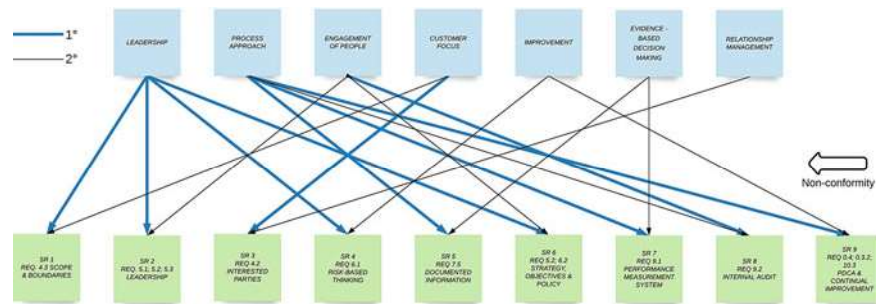


Fig. 2 The cause-and-effect relation between the requirements integration and the QMP

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.

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