International Journal of Occupational and Environmental Safety

Analysis of certified occupational health and safety management systems in Portugal

J. P. T. Domingues[a], P. Sampaio[b], P. M. Arezes[c]
[a]Production and Systems Engineering Department, University of Minho, Campus of Gualtar, PT (pdomingues@dps.uminho.pt) ORCID: 0000-0003-1406-4905. [b]Production and Systems Engineering Department, University of Minho, Campus of Gualtar, PT (paulosampaio@dps.uminho.pt) ORCID: 0000-0002-0879-1084. [c]Production and Systems Engineering Department, University of Minho, Campus of Azurém, PT (parezes@dps.uminho.pt) ORCID: 0000-0001-9421-9123.

Article History

Received 19 January 2017
Accepted 19 June 2017
Published 1 September 2017

Keywords

OHSMS
integrated management systems
Portugal
diffusion

DOI:
10.24840/2184-0954_001.001_0002
ISSN:
2184-0954
Type:
Research Article
Open Access
Peer Reviewed

Abstract

The systematic assurance of the occupational health, safety and wellbeing of the employees may be accomplished through the implementation (and certification) of standardized occupational health and safety management systems in accordance with the requirements listed in the BS OHSAS 18001 standard. In Portugal the certification of occupational health and safety management systems is usually carried out against the requirements of the BS OHSAS 18001 and the NP 4397 standard which is a national adaptation of the former. The purpose of this paper is to “snapshot” the diffusion of the certified occupational health and safety management systems in Portugal dissecting the following features: regional geographic location, integration phenomenon, evolution throughout the years, more involved activity sectors, more often found integrated management systems typologies and the most relevant and active certification bodies. To address this research goal a thorough, in-depth and comprehensive analysis of the data available in a Portuguese periodical publication (Barómetro da Certificação) was carried out. Results show that a great deal of the certified occupational health and safety management systems (96.3%) is integrated (in the sense that encompasses a multiple certification scheme). However the occupational health and safety management system is not typically the primordial subsystem of an integrated management system. In our view these results provide insights to the companies’ top management. On one hand, it seems that a patterned and “logical” path is pursued by the companies that seek organizational excellence- management systems integration. On the other hand, it seems that previously implemented subsystems, such as the quality management system, facilitate a “smoother” integration process encompassing the occupational health and safety management system.

1. INTRODUCTION

Undoubtedly these are the days of superb technological advances in all domains. This technological excellence we are experiencing asks for organizational excellence and an increasing amount of companies seek for it. Companies deal, in a day to day basis, with several stakeholders (customers, employees, society and suppliers among others) aiming at the fulfilment of their requirements. The implementation and certification of standardized management systems (MSs) enables a continuous and systematic assessment of the resources needed to fulfil the requirements of these stakeholders. Additionally, provides the organizational structure with a learning tool that minimizes and prevents any wrongdoing in future events. The occupational health and safety management systems (OHSMSs) are usually implemented supported on the BS OHSAS 18001 standard mainly due to the fact that this is a certifiable standard. Ultimately, an OHSMS encompasses policies, processes and procedures, *i.e.*, considers all the organizational best practices to fulfil and assure the occupational health

and safety requirements from the employees. The integration of MSs is a contemporary and hardly controllable phenomenon from the point of view of an academic researcher. Although this evidence asks for mainly qualitative research methods some relevant research findings may be possible through the analysis of quantitative data, namely, the data available throughout the years depicting the diffusion of the different MSs. This paper intends to adopt this latter methodology to point out and highlight several aspects concerning the OHSMSs in Portugal, notably, the integrated OHSMSs. To the best of our knowledge this is the first time that a comprehensive analysis of the integrated occupational health and safety management systems diffusion is developed in Portugal aiming at answering the following research questions:

How Portuguese OHSMS are diffused geographically, by activity sector and by certification body?

Which are the most often found integrated typologies encompassing the OHS subsystem?

The paper follows with a brief revision of the literature regarding the topics addressed in the OHSMSs mainstream literature, the diffusion of MSs where one may find the soundest works developed focusing other MSs than the OHSMS. Furthermore, the following subsections dissects the most recent reported studies concerning integrated management systems (IMSs) encompassing the OHSMS. The “Materials and Methods” section describes the research path adopted and discloses the main two bibliographic sources that supported the data collection. In order to improve the readability of the paper several subsections encompass the “Results and Discussion” section. Each subsection deals with the diffusion of the integrated OHSMSs considering a specific feature. The “Conclusions” section sums up the main conclusions that can be drawn from the results.

1.1. Certifiable Occupational Health and Safety Management Systems

There is a broad range of literature addressing a great deal of topics concerning occupational health and safety. The amount of papers addressing the certifiable OHSMSs, i.e., the organizational aspects of the occupational health and safety is comparative and noticeable scarce. However, it is possible to point out the main research topics and the major existing scientific gaps. In the last years several papers reported the implementation, or some aspects of it, of an OHSMS based on the OHSAS 18001 standard in SMEs (Saldaña et al., 2005) and in various activity sectors, such as, in the construction sector (Omran et al., 2008; Samuel and Munagala, 2016; Zeng et al., 2008), in the printing industry (Khodabocus and Constant, 2010), in the mining sector (Arruda and Gontijo, 2012), in the aeronautic industry (Dejanović and Heleta, 2016), in the automotive industry (Desa et al., 2013a), in the printed circuit board industry (Chen et al., 2009), in the waste treatment industry (Battaglia et al., 2015), in the multi-utility sector (Saracino et al., 2015), in the conventional power sector (Azadeh et al., 2012) and in the dairy industry (Autenrieth et al., 2016). Additionally, a stream of bibliography addressed the factors, determinants and influential aspects that seem to condition a successful implementation of the OHSMS. Concerning this research topic one should point out the papers authored by Rajaprasad and Chalapathi (2015), Ling et al. (2015), Ramli et al. (2011), Chen et al. (2009), Bianchini et al. (2017) and Bevilacqua et al. (2016). Some papers (Fernández-Muñiz et al., 2012a; Santos et al., 2013) reported and stressed out the benefits collected from OHSMS implementation, the perceptions and attitudes from certified OHSMS companies regarding safety behaviour and its effectiveness (Robson et al., 2007; Chen and Li, 2012). Other papers focused on the assessment of the OHSMS (Abad et al., 2013; Inan et al., 2017), on the performance of the OHSMS (Azadeh et al., 2012.; Desa et al., 2013b; Lo et al., 2014), on the comparison between the OHSAS 18001 and national standards (Abidin and Irniza, 2015), between certified and non-certified companies concerning safety climate (Ghahramani, 2016) and point out and promote linkages between the OHSMS implementation with other constructs or aspects such as sustainability (Marhani et al., 2013; Qi et al., 2013), voluntary safety management (Paas et al., 2015), safety behaviour (Fernández-Muñiz et al., 2012b), participatory ergonomics (Yazdani *et al.*, 2015), psychosocial risks (Jespersen et al., 2016), safety management (Vinodkumar and Bhasi, 2011), organizational learning (Granerud and Rocha, 2011; Silva et al., 2017) and decision making aiming at effectiveness improvement (Mohammadfam et al., 2016). Some recent published papers address the OHSMS in an

integrated context and other dissect some pertinent and relevant IT issues aiming at a successful management of the system of systems. Among these papers one should highlight those authored by Yew and Goh (2015), Domingues et al. (2016a,b), Ifadiana and Soemirat (2016), Rueda and Gómez (2016), Holubová (2016), Barafort et al. (2016), Barata et al. (2017) and Pandi et al. (2016).

Although the majority of the mainstream bibliography considers the OHSMS certification as an add-value some papers point out some shortcomings. Hohnen and Hasle (2011) stressed that "…unintentionally… the certified management system does not necessarily tackle the most urgent work environment issues and may exclude important aspects of the work environment such as psychosocial factors." mainly due to the fact that the certified OHSMS "… create an environment of 'measurable and auditable facts'…" strongly focused on legal and market requirements.

1.2. Diffusion of management systems

To our knowledge there is not, at this time, a comprehensive assessment of the integrated or non-integrated OHSMSs diffusion at a regional or worldwide level. This fact relates mainly to the lack of information sources concerning national diffusion of OHSMS and the fact that ISO Survey of Certifications do not publishes data concerning OHSMS (OHSAS 18001). ISO Survey of Certifications reports, each year, the data concerning ISO 9001 and ISO 14001 (among others) issued certificates by country which enables the evaluation and monitoring of the certificates diffusion by macro regions.

Some previous reported studies may be considered as references or benchmarks to the work intended to be developed regarding integrated management systems (IMSs). The analysis of the geographic diffusion of the ISO 9001 issued certificates was targeted by the work of Sampaio et al. (2009, 2010), Sampaio and Saraiva (2011), Salgado and Sampaio (2013), Viadiu et al. (2006), Neumayer and Perkins (2005), Mangiarotti and Riillo (2010) and Franceschini et al. (2004). Concerning the geographic diffusion of ISO 14001 certificates one should point out the work developed by Casadesús et al. (2008), Marimon et al. (2011) and Peixe et al. (2012). More recently, the work developed by Zayas et al. (2016) dissecting the ISO 9001- and ISO 14001- registered service organizations in Murcia (Spain) should be mentioned. The analysis by activity sector was reported by Llach et al. (2011) and Marimon et al. (2011) and, meanwhile, Marimon et al. (2009) proposed a projective model for the decline phase of ISO 9000 and ISO 14000 certifications. The certifications according some sector specific standards were also focused namely the ISO/TS 16949 (automotive industry) standard (Franceschini et al., 2011). These works enabled the development of forecasting models, highlighted the features that seem to condition a successful dispersion of certificates, outlined the path to sustainable certification programs, identified the drivers and determinants for ISO 9001 and ISO 14001 certification and pointed out those countries where a saturation level apparently had been reached. This paper intends to report the results from a similar descriptive analysis focusing the integrated OHSMSs in Portugal.

1.3. Integrated management systems

Various literature streams are distinguishable concerning the research focusing on the domain of IMSs. Although not constrained by any peculiar limitation, the revision of the literature addressing the domain of IMSs establishes and discloses some topics commonly analysed. Usually, the shortcomings of non-integrated management (Domingues et al., 2014), the benefits of MSs integration (Bernardo et al., 2015; Ashfaquddin and Khan, 2016) and the reasons and obstacles of the integration process (Kauppila et al., 2015) are topics addressed. Additionally, the attained integration levels (Almeida et al., 2014), the audit function (Cook et al., 2016) as a potential enabler and guidelines to proceed with a successful MSs integration (Sampaio et al., 2012; Vaughen et al., 2015) are also topics focused in a great deal of papers. Furthermore, several models and frameworks aiming at a well succeeded integration are commonly reported by academic researchers (Genaro and Loureiro, 2015). A recent revision of the topics addressed in the IMSs research domain was published elsewhere (Domingues et al., 2014). Table 1 lists some of the papers published throughout 2015 and 2016 focusing specifically the phenomenon of MSs integration or, at least, addressing some subtopics within.

Table 1. Papers addressing several topics of the IMSs research in 2015 and 2016.

Author	Scope / Topic	Obs
Bernardo *et al.* (2015)	Revision of literature concerning the benefits of MSs integration.	**
Carvalho *et al.* (2015)	The paper dissects some of the benefits of the integration of the QMS, EMS and OHSMS.	
Cook *et al.* (2016)	The authors dissect the topic of environmental audits.	
Domingues *et al.* (2016)	The authors present a model to assess IMSs maturity.	*
Genaro and Loureiro (2015)	The authors present a model aiming at IMSs from a stakeholder perspective.	*
Gianni and Gotzamani (2015)	The authors describe a case where MSs integration was unsuccessful.	*
Kauppila *et al.* (2015)	The authors point out some potential trends concerning IMSs.	
Klute-Wenig and Refflinghaus (2015)	The authors suggest how to integrate some sustainability issues into an IMS.	
Mesquida and Mas (2015)	The authors point out some issues concerning the IT service management from an integrated perspective.	
Mežinska *et al.* (2015)	The authors dissect the constructs of sustainability and social responsibility from the point of view of MSs integration.	
Rößler and Schlieter (2015)	MSs integration from a model-based perspective.	*
Samy *et al.* (2015)	The authors discuss MSs integration from the environmental perspective and as enabling sustainable development.	
Savino and Batbaatar (2015)	Resources for IMSs.	
Su *et al.* (2015)	Strategies for MSs integration.	*
Vaughen *et al.* (2015)	The authors list some guidelines for MSs integration.	
Visser and Kymal (2015)	The authors dissect the construct of integrated value creation (IVC).	*

* of special interest; ** of outstanding interest. (Authors own elaboration and classification)

2. MATERIALS AND METHODS

A thorough analysis of two Portuguese publications (*Barómetro da Certificação* and *Guia de Empresas Certificadas- GEC*) was carried out. These publications report once a year the evolution of the number of certifiable MSs, such as, the Quality Management Systems (QMS), the Environmental Management System (EMS) and the OHSMS. The results (till 31/12/2014) from integrated OHSMSs encompassing the following typologies were considered: QMS+EMS+OHSMS; QMS+OHSMS and EMS+OHSMS. In order to clarify further reading one should point out that, concerning the current paper, the population under study encompasses the Portuguese integrated OHSMSs (certified) comprising the following three typologies: ISO 9001+ISO 14001+OHSAS 18001, ISO 9001+OHSAS 18001 and ISO 14001+OHSAS 18001. It should also be emphasized that 'Integrated OHSMSs' solely represents, in this paper, OHSMSs cohabiting simultaneously with other MSs due to the fact that it is not possible to evaluate the actual level of integration achieved.

3. RESULTS AND DISCUSSION

3.1. Diffusion of Portuguese OHSMS

By the end of 2014 there were 1121 issued certificates according to the OHSAS 18001 standard (Figure 1) which accounts for 0.11 organizations per 1000 inhabitants and 2.78% of the Portuguese organizations with 10 or more employees. From September 2007 to December 2014 the amount of issued certificates almost tripled and consistently increased throughout the years.

Figure 2 presents the evolution throughout the years (2007-2014) of the number of organizations solely holding the OHSMS certification. One can see that a great deal of the organizations hold the OHSMS certification in addition to other MSs certifications. According to

Figure 2, by the end of 2014 (the most recent data), there were 42 organizations solely holding the OHSMS certification.

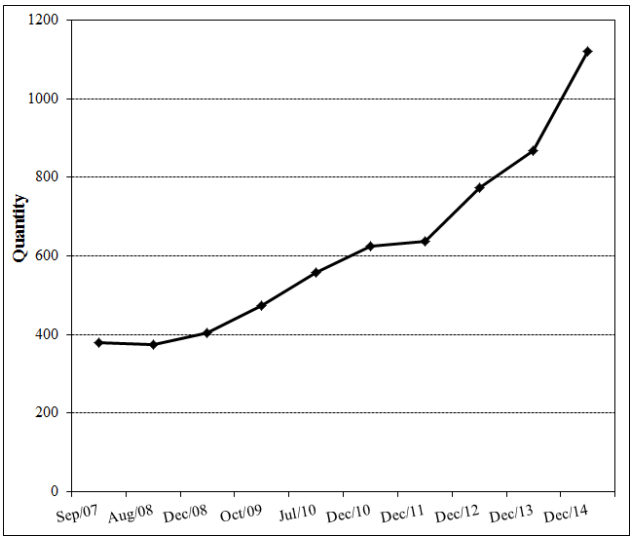

Figure 1. Time evolution of the total OHSMSs (Portugal).

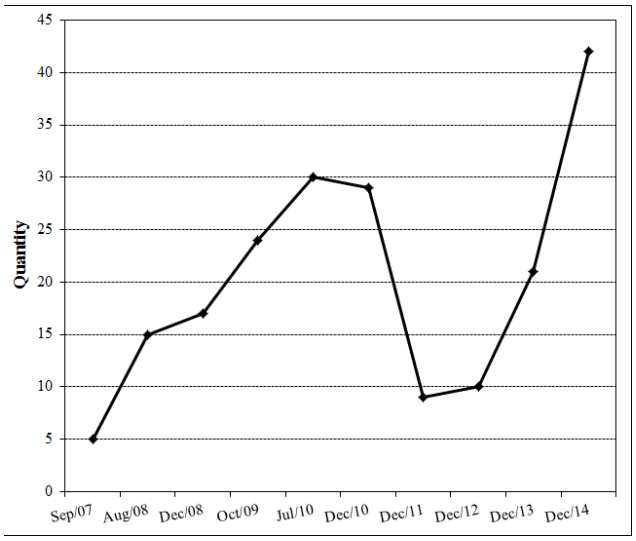

Figure 2. Time evolution (2007-2014) of the number of companies solely holding OHSMS certification (Portugal).

Based on the data provided by both Figures 1 and 2 one should stress that a remarkable high percentage of the certified OHSMSs are integrated with other management subsystems. In fact, the percentage of companies that adopted a single OHSMS is fairly low (Figure 3) being around 3.7% considering the last available data.

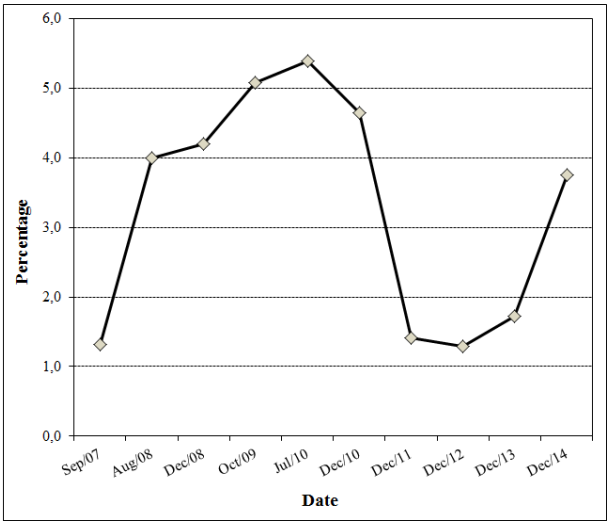

Figure 3. Time evolution of the percentage of non-integrated OHSMSs (Portugal).

If one look back throughout the previous years it is possible to conclude that seldom are the companies that opted by the OHSMS as the primordial subsystem focusing the development, implementation and certification of a hypothetical and potential IMS. In fact, according to Figure 3, the higher percentage of non-integrated OHSMSs was reported in 2010 and barely surpasses 5.0%. The evolution of the number of OHSAS 18001 issued certificates (breakdown by NUT II region) is presented in Figure 4.

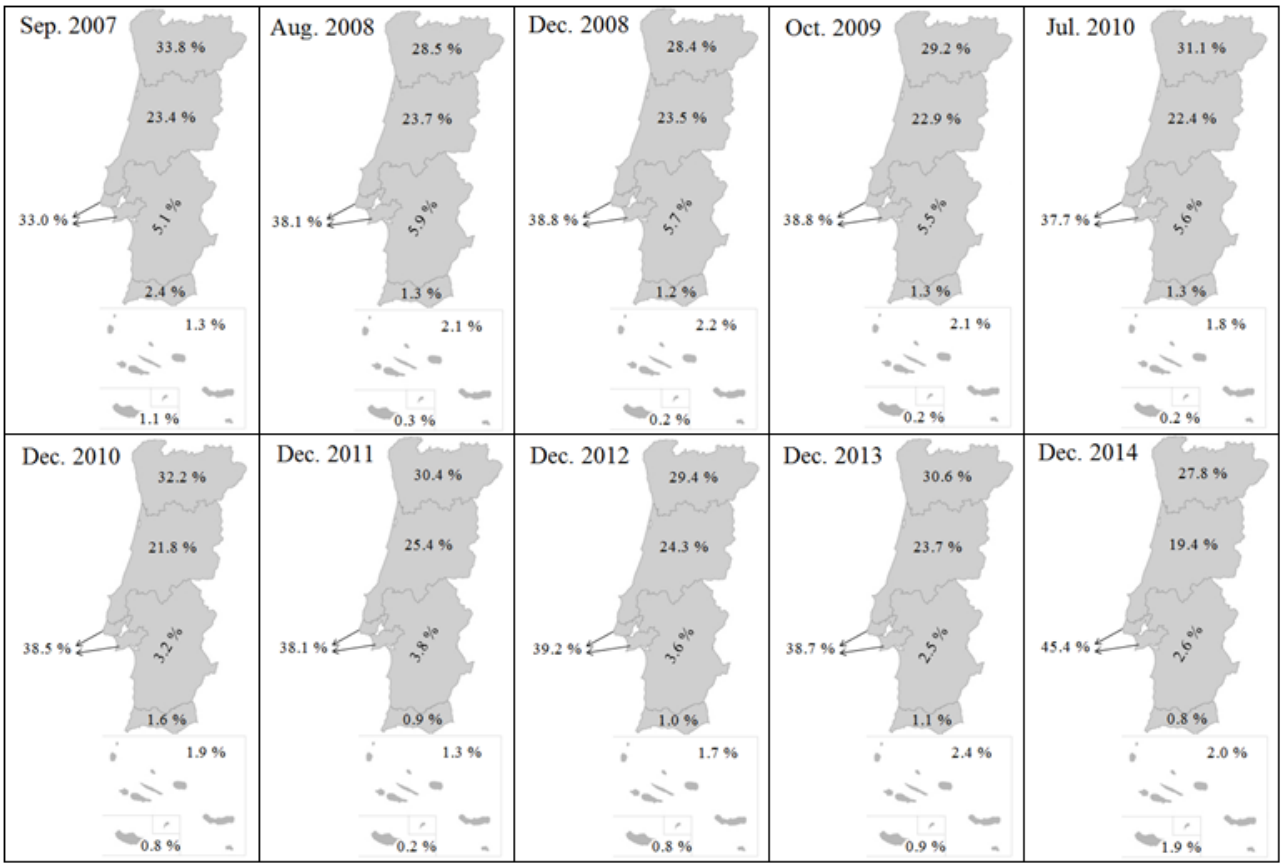

Figure 4. Evolution of OHSAS 18001 certificates- Breakdown by NUT II region.

The most relevant NUT II regions (number of OHSAS 18001 certificates) are the North, Centre and Lisbon. Nearly 90.0% of the issued OHSAS 18001 certificates are awarded in these regions, throughout the years. These results may be explained by the density of the number of companies operating in these particular regions. The relative relevance of the Alentejo region is being steadily decreasing which suggest that this region reached the saturation level concerning the OHSMS certification. The number of issued certificates in the regions of Algarve, Azores and Madeira account for less than 5.0% of the total awarded OHSAS certificates and it was not possible the identification of a consistent and peculiar trend towards an increase or decrease of the number of awarded certificates. The most relevant and active certification bodies operating in the OHS domain are APCER (*Associação Portuguesa de Certificação*) and SGS (*Société Générale de Surveillance*) (Figure 5). Nearly 70.0% of the OHSAS 18001 certificates are issued by these two certification bodies (Figure 5). Concerning the activity sectors more involved with the OHS certification (Figure 6 and Table A1- Appendix: Activity Code) one should highlight the construction sector (AC 28), the electricity supply sector (AC 25), the engineering services (AC 34) and other services (AC 35). Those activity sectors not depicted in Figure 6 accounts for less than 2.0% of total certified OHSMSs each.

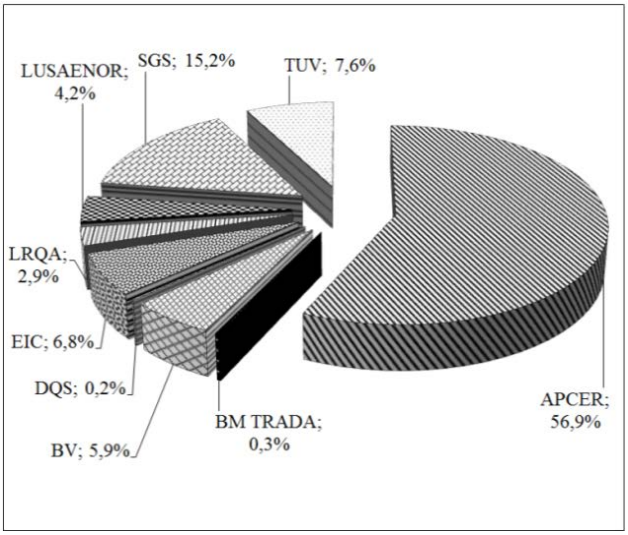

Figure 5. Certification entities more involved with OHSMSs (Portugal).

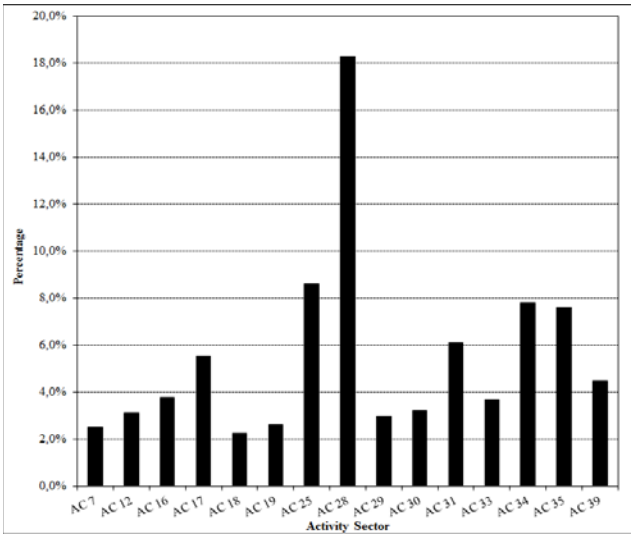

Figure 6. Certified OHSMSs- Breakdown by the more involved activity sectors (Portugal).

3.2. Integrated OHSMSs

The following subsections address each of them, a specific aspect of the diffusion of integrated OHSMSs and are presented separately in order to improve the paper readability although its interpretation should be performed taking into account all of them. As stressed previously, the OHSMS usually encompasses an integrated management system that comprises the QMS and the EMS. By the end of 2014 there were 946 OHSMSs operating simultaneously with the QMS, with the EMS or with both. Figure 7 presents these different typologies by NUT II region. In all the NUT II regions the most relevant typology is the one that comprises the three management subsystems (QMS, EMS and OHSMS). Furthermore, it is possible to point out that the Lisbon region leads the number of companies operating with the three subsystems typology. However, the North region leads in the other two remaining typologies (QMS+OHSMS and EMS+OHSMS). Additionally, it is possible to observe the minor contribution of the Alentejo, Algarve, Azores and Madeira regions to the overall integrated OHSMSs. Concerning the evolution throughout the years of the amount of the different typologies (Figure 8) one may conclude that the QMS+OHSMS and the EMS+OHSMS typologies seem to be an intermediary step to the QMS+EMS+OHSMS typology. In fact, if one dissect the data displayed in Figure 8 some patterns emerge: the amount of the QMS+OHSMS and EMS+OHSMS typologies do not increase consistently and systematically throughout the years; the inflexion points detected in the evolution of the QMS+EMS+OHSMS seem to match symmetric inflexion points in the evolution of the QMS+OHSMS and EMS+OHSMS typologies. These patterns concur with the notion that these two subsystems typologies are preliminary phases to achieve the ultimate system- the integrated QMS+EMS+OHSMS. It should also be highlighted that the amount of integrated QMS+EMS+OHSMS nearly tripled in the time period of seven years.

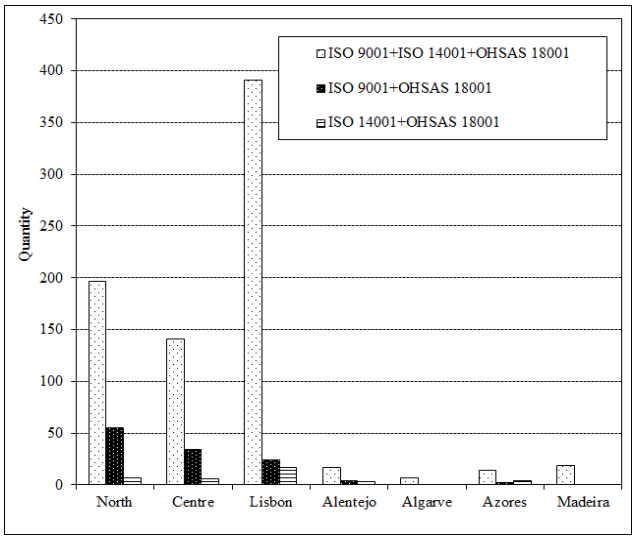

Figure 7. Integrated OHSMSs- Breakdown by typology and NUT II region (Portugal- 31/Dec/2014).

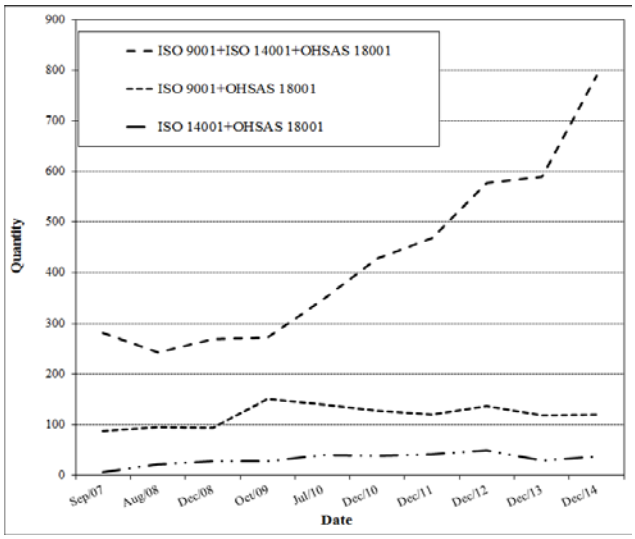

Figure 8. Evolution of the integrated OHSMSs- Breakdown by Typology (Portugal).

In addition to the most common and relevant integrated typologies there are several IMSs that encompasses other management subsystems (Table 2). The integration of the OHSAS 18001 standard with some sector specific standards such as the ISO 22000 standard (Food safety management systems) and ISO/TS 16949 standard (Quality management systems- Particular requirements for the application of ISO 9001:2008 for automotive production and relevant service part organizations) was favoured by several companies. Additionally, other companies opted to integrate the OHSAS standard with the SA 8000 (Social accountability international) and EMAS instrument (Eco-Management and Audit Scheme) aiming at addressing the requirements from other stakeholders than the customers and the employees.

Table 2. Other integrated typologies encompassing the OHSMS.

TYPOLOGY	NUMBER OF ORGANIZATIONS
OHSAS 18001 + ISO 22000	1
OHSAS 18001 + EMAS	1
ISO 9001 + ISO 14001 + OHSAS 18001 + ISO 22000	18
ISO 9001 + ISO 14001 + OHSAS 18001 + ISO 22000 + SA 8000	5
ISO 14001 + OHSAS 18001 + ISO 22000	1
ISO 14001 + OHSAS 18001 + ISO 22000	1
ISO 14001 + OHSAS 18001 + EMAS	5
ISO 14001 + OHSAS 18001 + ISO/TS 16949	6

Figures 8 to 10 display the relevance of the operating certification bodies breakdown by integrated typology. It is possible to observe that APCER is the most influential certification body, notably, in the ISO 9001+ISO 14001+OHSAS 18001 and in the ISO 9001+OHSAS 18001 typologies. Concerning the ISO 14001+OHSAS 18001 typology the relevance of APCER is lower than 50.0% of market share. TUV (*Technischer Überwachungsverein*) and SGS account for 23.0% and 27.5% of the market share (respectively for ISO 9001+ISO 14001+OHSAS 18001 and ISO 9001+OHSAS 18001 typologies).

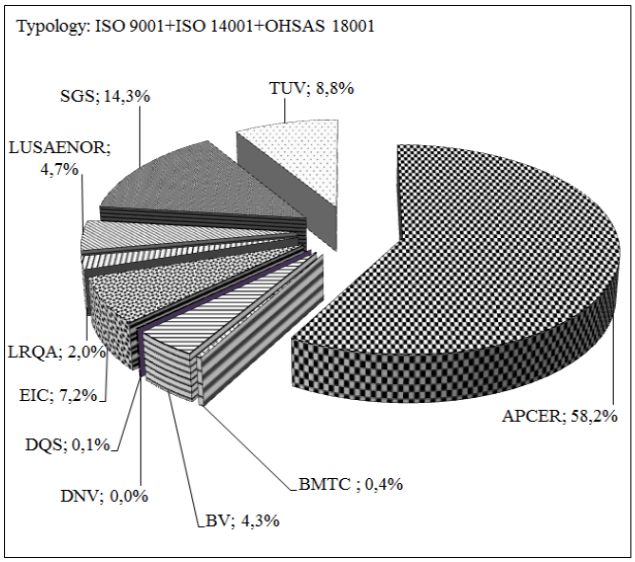

Figure 8. Relevant certification bodies involved with the ISO 9001+ISO 14001+OHSAS 18001 integrated typology.

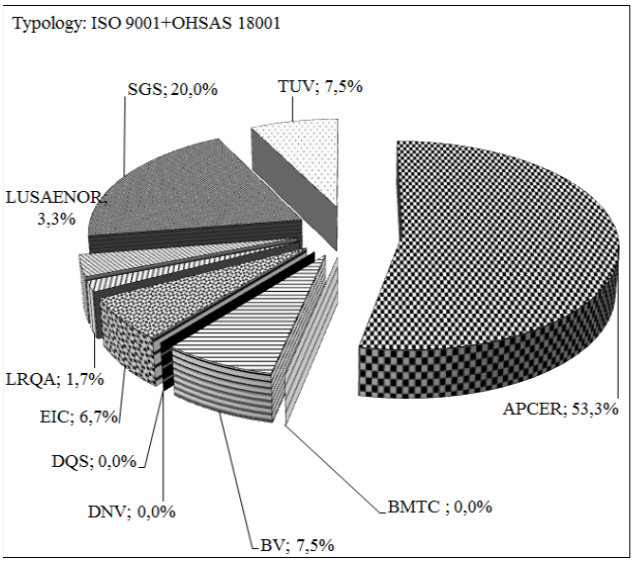

Figure 9. Relevant certification bodies involved with the ISO 9001+OHSAS 18001 integrated typology.

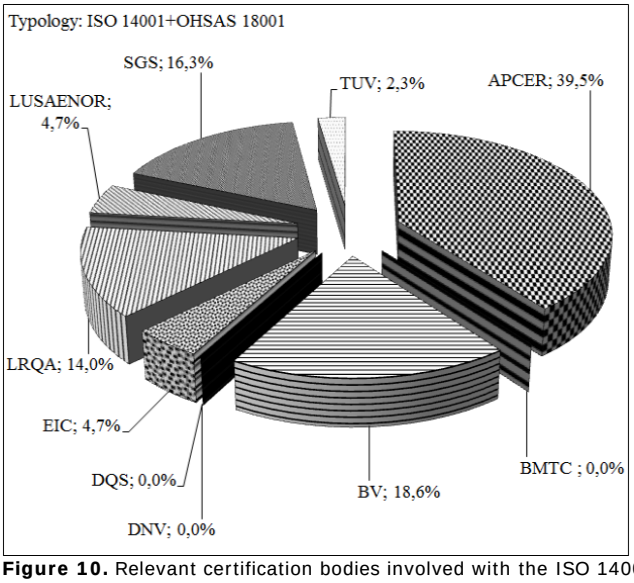

Figure 10. Relevant certification bodies involved with the ISO 14001+OHSAS 18001 integrated typology.

Concerning the more involved activity sectors one should state, based on Figures 11 and 12, that the construction sector (AC 28) leads the number of companies operating with an IMS encompassing the ISO 9001+ISO 14001+OHSAS 18001 standards and the ISO 9001+OHSAS 18001 standards. However, regarding the ISO 14001+OHSAS 18001 typology (Figure 13) the "Transport, storage and communication" (AC 31) is the most relevant activity sector. It should be pointed out that the "Electricity supply" activity sector (AC 25) has a great deal of companies operating through a ISO 9001+ISO 14001+OHSAS 18001 typology but none operating through a ISO 9001+OHSAS 18001 typology. Regarding the typology ISO 14001+OHSAS 18001 one should stress the relevance of the "Financial intermediation, real estate, rental" (AC 32) and "Gas supply" (AC 26) activity sectors.

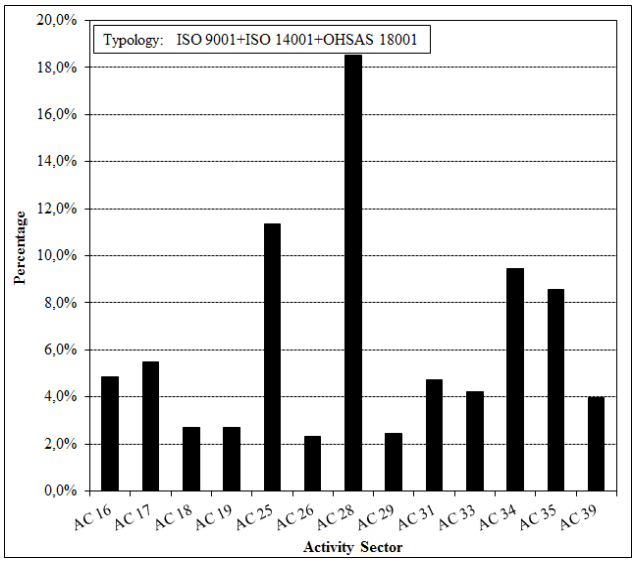

Figure 11. Integrated Typology ISO 9001+ISO 14001+OHSAS 18001: Breakdown by activity sectors.

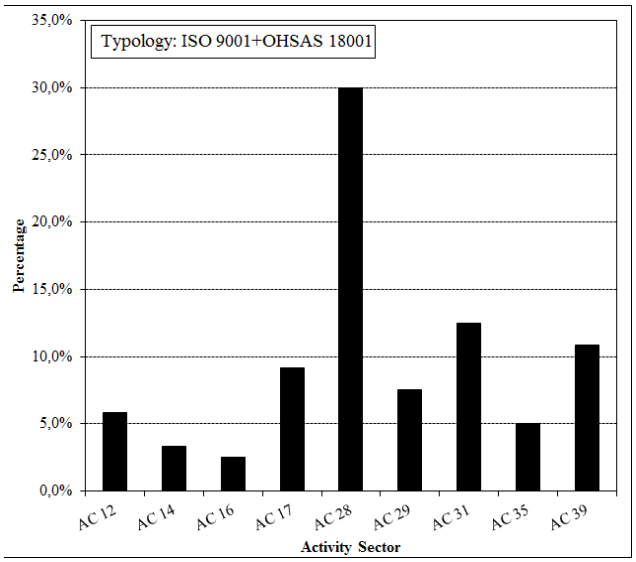

Figure 12. Integrated Typology ISO 9001+OHSAS 18001: Breakdown by activity sectors.

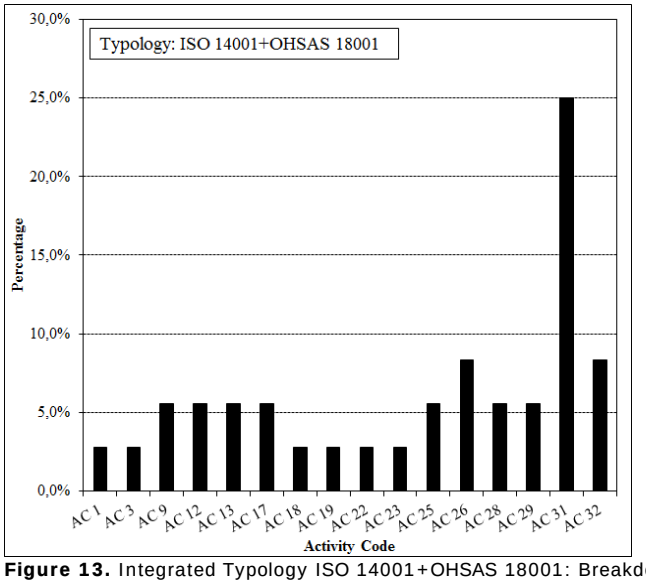

Figure 13. Integrated Typology ISO 14001+OHSAS 18001: Breakdown by activity sectors.

Figure 14 displays the evolution of the several integrated typologies by NUT II regions. The North, Centre and Lisbon contribute the most to the overall integrated OHSMSs. Furthermore, results suggest that in the Centre region the ISO 9001+ISO 14001+OHSAS 18001 typology reached the saturation level. However, this seems to be not the case in the North and Lisbon regions. Concerning the ISO 9001+OHSAS 18001 and the ISO 14001+OHSAS 18001 typologies it is possible to point out that there is not a systematic and consistent increase of the number of certificates which concurs with the previous pointed out notion that these integrated typologies are an intermediary step towards the integrated typology encompassing the three subsystems.

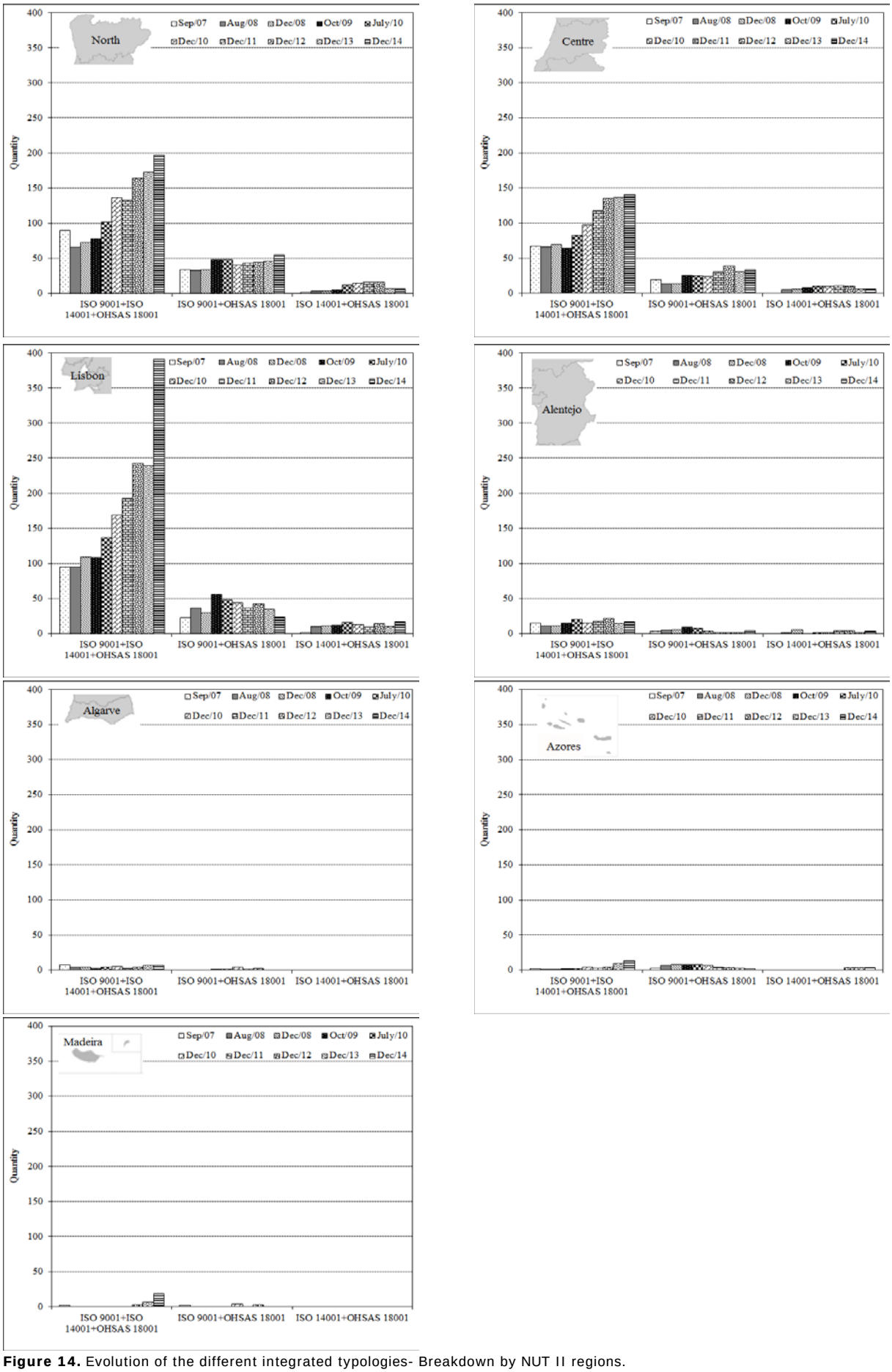

Figure 14. Evolution of the different integrated typologies- Breakdown by NUT II regions.

Concerning the Madeira and Azores regions one should state that the amount of integrated OHSMSs was barely noticeable at 2011. After that a consistent increase is reported and, simultaneously, a similar decrease in the other typologies. Both Algarve and Madeira regions never reported a single company operating through an ISO 14001+OHSAS 18001 typology and, additionally, the reported amount of operating companies through an ISO 9001+OHSAS 18001 reaches zero in several years.

4. CONCLUSIONS

This paper dissected the diffusion and evolution of the amount of companies holding the OHSAS 18001 certification in Portugal. Several particular dimensions were analysed, notably, the geographic dispersion, the most relevant certification bodies, the more involved activity sectors and the different integrated typologies. A noticeable high percentage of the certified OHSMSs are integrated with other MSs, notably, the QMS (ISO 9001) and the EMS (ISO 14001). The last available data (by the end of 2014) the percentage of companies that adopted the OHSMS as the single MS was around 3.7%. Concerning the evolution throughout the last years, it is possible to conclude that seldom are the companies that opted by the OHSMS as the primordial subsystem of a potential and future IMS. The most relevant NUT II regions (number of OHSAS 18001 certificates) are the North, Centre and Lisbon and the OHSMS is often found integrated with the QMS and EMS. The integrated typologies encompassing the QMS and the OHSMS or the EMS and the OHSMS are also relevant although not so prominent as the three subsystems typology and results suggest that these typologies act as a previous phase to the ultimate IMS. As a shortcoming of this study, one should stress that the unavailability of data from other countries prevents a benchmark analysis and the identification of the convergent dimensions. Conversely, from other perspective, this paper and the analysis within may be considered as a pioneer study enabling researchers from other countries to replicate it. As stated in the abstract section, one should stress that throughout the text the concept “integrated management system” intended to portray those management systems encompassing multiple certifications. Although the well-established notion of different levels of integration and different maturity levels of an IMS (reported in the bibliography) no assessment regarding the level of integration attained by the companies was carried out. We do believe that this issue entails a limitation of the current study.

ACKNOWLEDGEMENTS

The authors acknowledge the support of CemPalavras edições empresariais and to Luís Morais. This work has been supported by FCT – Fundação para a Ciência e Tecnologia in the scope of the project: PEst-OE/EEI/UI0319/2014. Pedro Domingues is supported by FCT Post-Doc Grant SFRH/BPD/103322/2014.

REFERENCES

Abad, J., Lafuente, E. and Vilajosana, J., 2013. An assessment of the OHSAS 18001 certification process: Objective drivers and consequences on safety performance and labour productivity. Saf. Sci. 60, 47e56. DOI: 10.1016/j.ssci.2013.06.011.

Abidin, E.Z. and Irniza, R., 2015. Occupational safety and health management system in Malaysia: Comparison between OHSAS 18001:2007 and MS 1722: 2011. International Journal of Public Health and Clinical Sciences 2 (3), 23e32. Available at http://publichealthmy.org/ejournal/ojs2/index.php/ijphcs/article/view/175.

Almeida, J., Domingues, J.P.T. and Sampaio, P., 2014. Different perspectives on management systems integration. Total Quality Management and Business Excellence 25 (3-4), 338e351. DOI: 10.1080/14783363.2013.867098.

Arruda, A.F.V. and Gontijo, L.M., 2012. Application of ergonomics principles in underground mines through the Occupational Safety and Health Management System- OSHMS OHSAS 18.001:2007. Work 41, 4460e4467. DOI: 10.3233/WOR-2012-0119-4460.

Azadeh, A., Farmand, A.H. and Sharahi, Z.J., 2012. Performance assessment and optimization of HSE management systems with human error and ambiguity by an integrated fuzzy multivariate approach in a large conventional power plant manufacturer. J. Loss. Prev. Process. Ind. 25, 594e603. DOI: 10.1016/j.jlp.2012.01.003.

Ashfaquddin, S.M. and Khan, R. 2016. A study of benefits for selected organization in Marathwada region by ISO 9001 implementation and certification. Indian J. Appl. Res. 6 (9), 346e352. Available at https://www.worldwidejournals.com/indian-journal-of-applied-research-(IJAR)/articles.php?val=MTAxMDY=&b1=285&k=72.

Autenrieth, D.A., Brazile, W.J., Sandfort, D.R., Douphrate, D.I., Román-Muñiz, I.N. and Reynolds, S.J., 2016. The associations between occupational health and safety management system programming level and prior injury and illness rates in the U.S. dairy industry. Saf. Sci. 84, 108e116. DOI: 10.1016/j.ssci.2015.12.008.

Barata, J., Cunha, P.R. and Santos, A.P.M., 2017. Mind the gap: Assessing alignment between hospital quality and its information systems. Information Technology for Development, in press. DOI: 10.1080/02681102.2016.1197173.

Barafort, B., Mesquida, A.-L., and Mas, A., 2016. Integrating Risk Management in IT settings from ISO Standards and Management Systems Perspectives. Computer Standards & Interfaces, in press. DOI: 10.1016/j.csi.2016.11.010.

Barómetro da Certificação, CemPalavras edts. By Domingues, J.P.T., Sampaio, P. and Saraiva, P. 2015.

Battaglia, M., Passetti, E. and Frey, M., 2015. Occupational health and safety management in municipal waste companies: A note on the Italian sector. Saf. Sci. 72, 55e65. DOI: 10.1016/j.ssci.2014.08.002.

Bernardo, M., Simon, A., Tarí, J.J. and Molina-Azorín, J.F., 2015. Benefits of management systems integration: A literature review. J. Clean. Prod. 94, 260e267. DOI: 10.1016/j.jclepro.2015.01.075.

Bevilacqua, M., Ciarapica, F.E. and De Sanctis, I., 2016. How to successfully implement OHSAS 18001: The Italian case. J. Loss. Prev. Process. Ind. 44, 31e43. DOI: 10.1016/j.jlp.2016.08.004.

Bianchini, A., Donini, F., Pellegrini, M. and Saccani, C., 2017. An innovative methodology for measuring the effective implementation of an Occupational Health and Safety Management System in the European Union. Saf. Sci. 92, 26e33. DOI: 10.1016/j.ssci.2016.09.012.

Carvalho, K.M.P., Picchi, F., Camarini, G. and Chamon, M.Q.O., 2015. Benefits in the implementation of safety, health, environmental and quality integrated system. International Journal of Engineering and Technology 7 (4), 333e338. DOI: 10.7763/ijet.2015.v7.814.

Casadesús, M., Marimon, F. and Heras, I., 2008. ISO 14001 diffusion after the success of the ISO 9001 model. J. Clean. Prod. 16, 1741e1754. DOI: 10.1016/j.jclepro.2007.11.002.

Chen, C.-Y., Wu, G.-S., Chuang, K.-J. and Ma, C.-M., 2009. A comparative analysis of the factors affecting the implementation of occupational health and safety management systems in the printed circuit board industry in Taiwan. J. Loss. Prev. Process. Ind. 22, 210e215. DOI: 10.1016/j.jlp.2009.01.004.

Chen, Q. and Li, S., 2012. Research about the level of operational state of OHSMS in a group company. Procedia Eng. 43, 556e560. DOI: 10.1016/j.proeng.2012.08.097.

Cook, W., van Bommel, S. and Turnhout, E., 2016. Inside environmental auditing: Effectiveness, objectivity, and transparency. Curr. Opin. Environ. Sustain. 18, 33e39. DOI: 10.1016/j.cosust.2015.07.016.

Dejanović, D. and Heleta, M., 2016. An airport occupational health and safety management system from the OHSAS 18001 perspective. Int. J. Occup. Saf. Ergon. 22 (3), 439e447. DOI: 10.1080/10803548.2016.1165387.

Desa, A.F.N.C., Habidin, N.F., Hibadullah, S.N., Fuzi, N.M. & Zamri, F.I.M., 2013a. The impact of Occupational Safety and Health administration practices (OSHAP) and OHSAS 18001 efforts in Malaysian automotive industry. Journal of App. Sci. and Rese. 1 (1), 47e59.

Desa, A.F.N.C., Habidin, N.F., Hibadullah, S.N., Fuzi, N.M. and Zamri, F.I.M., 2013b. OHSAS 18001 performances efforts and OSHA performance in Malaysian automotive industry. Journal of Environmental Science, Computer Science and Engineering & Technology 2 (2), 217e227.

Domingues, J.P.T., Fonseca, L., Sampaio, P. and Arezes, P.M., 2016a. Integrated versus non-integrated perspectives of auditors concerning the new ISO 9001 revision. In proceedings of the 2016 IEEE International Conference on Industrial Engineering and Engineering Management, Bali, Indonesia, 4-7 December, ISBN: 978-1-5090-3665-3, 866e870. DOI: 10.1109/IEEM.2016.7798000.

Domingues, J.P.T, Sampaio, P. and Arezes, P.M., 2014. Analysis of integrated management systems from various perspectives. Total Quality Management and Business Excellence 26 (11-12), 1311e1334. DOI: 10.1080/14783363.2014.931064.

Domingues, J.P.T, Sampaio, P. and Arezes, P.M., 2015. Chapter 11- Integrated management systems: A model for maturity assessment. In Peris-Ortiz *et al.* (Edts), Achieving Competitive Advantage through Quality Management, Springer, 1st edition, ISBN: 978-3-319-17251-4.

Domingues, J.P.T., Sampaio, P. and Arezes, P.M., 2016b. Integrated management systems assessment: a maturity model proposal. J. Clean. Prod. 124, 164e174. DOI: 10.1016/j.jclepro.2016.02.103.

Fernández-Muñiz, B., Montes-Peón, J.M. and Vázquez-Ordás, C.J., 2012a. Occupational risk management under the OHSAS 18001 standard: analysis of perceptions and attitudes of certified firms. J. Clean. Prod. 24, 36e47. DOI: 10.1016/j.jclepro.2011.11.008.

Fernández-Muñiz, B., Montes-Peón, J.M. and Vázquez-Ordás, C.J., 2012b. Safety climate in OHSAS 18001-certified organisations: Antecedents and consequences of safety behaviour. Accid. Anal. Prev. 45, 745e758. DOI: 10.1016/j.aap.2011.10.002.

Franceschini, F., Galetto, M. and Gianni, G., 2004. A new forecasting model for the diffusion of ISO 9000 standard certifications in European countries. International Journal of Quality and Reliability Management 21 (1), 32e50. DOI: 10.1108/02656710410511687.

Franceschini, F., Galetto, M., Maisano, D. and Mastrogiacomo, L., 2011. ISO/TS 16949: analysis of the diffusion and current trends. In proceedings of the Institution of Mechanical Engineers Journal of Engineering Manufacture, Vol. 225(Part B), 735e745.

Genaro, A.F.S. and Loureiro, G., 2015. Stakeholder management as an approach to integrated management system (IMS_{STK}). In Curran et al. (Edts), Transdisciplinary Lifecycle Analysis of Systems, IOS Press, ISBN: 978-1-61499-543-2.

Ghahramani, A., 2016. An investigation of safety climate in OHSAS 18001- certified and non-certified organizations. Int. J. Occup. Saf. Ergon. 22 (3), 414e421. DOI: 10.1080/10803548.2016.1155803.

Gianni, M. and Gotzamani, K., 2015. Management systems integration: lessons learned from an abandonment case. J. Clean. Prod. 86, 265e276. DOI: 10.1016/j.jclepro.2014.08.023.

Granerud, L. and Rocha, R.S., 2011. Organisational learning and continuous improvement of health and safety in certified manufacturers. Saf. Sci. 49, 1030e1039. DOI: 10.1016/j.ssci.2011.01.009.

Guia de Empresas Certificadas, 2014, CemPalavras Editions.

Holubová, V., 2016. Integrated safety management systems. Polish Journal of Management Studies 14 (1), 106e118. DOI: 10.17512/pjms.2016.14.1.10.

Hohnen, P. and Hasle, P., 2011. Making work environment auditable- A 'critical case' study of certified occupational health and safety management systems in Denmark. Saf. Sci. 49, 1022e1029. DOI: 10.1016/j.ssci.2010.12.005.

Ifadiana, D.P. and Soemirat, J., 2016. An analysis of the effect of the implementation of an integrated management system (IMS) on work ergonomics in an O&M power plant company. Journal of Engineering and Technological Sciences 48 (2), 173e182. DOI: 10.5614/j.eng.technol.sci.2016.48.2.4.

Inan, U.H., Gül, S. and Yılmaz, H., 2017. A multiple attribute decision model to compare the firms' occupational health and safety management perspectives. Saf. Sci. 91, 221e231. DOI: 10.1016/j.ssci.2016.08.018.

Jespersen, A.H., Hohnen, P. and Hasle, P., 2016. Internal audits of psychosocial risks at workplaces with certified OHS management systems. Saf. Sci. 84, 201e209. DOI: 10.1016/j.ssci.2015.12.013.

Kauppila, O., Härkönen, J. and Väyrynen, S., 2015. Integrated HSEQ management systems: Developments and trends. International Journal for Quality Research 9 (2), 231e242. Available at http://www.ijqr.net/paper.php?id=344.

Khodabocus, B.F. and Constant, K.C., 2010. Implementing OHSAS 18001:2007- A case study of hazard analysis from the printing industry. International Journal of Engineering Research in Africa 1, 17e27. DOI: 10.4028/www.scientific.net/JERA.1.17.

Klute-Wenig, S. and Refflinghaus, R., 2015. Integrating sustainability aspects into an integrated management system. The TQM Journal 27 (3), 303e315. DOI: 10.1108/TQM-12-2013-0128.

Llach, J., Marimon, F. and Bernardo, M., 2011. ISO 9001 diffusion analysis according to activity sector. Ind. Manage. Data Syst. 111 (2), 298e316. DOI: 10.1108/02635571111115191.

Ling, T.C., Hashim, F. and Liang, C.W., 2015. Occupational Health and Safety Advisory Services (OHSAS) 18001 management system adoption: Assessing the determinants. Jurnal Pengurusan 43, 61e72. Available at http://ejournal.ukm.my/pengurusan/article/view/11122.

Lo, C.K.Y., Pagell, M., Fan, D., Wiengarten, F. and Yeung, A.C.L., 2014. OHSAS 18001 certification and operating performance: The role of complexity and coupling. J. Oper. Manag. 32, 268e280. DOI: 10.1016/j.jom.2014.04.004.

Marhani, M.A., Adnan, H. and Ismail, F., 2013. OHSAS 18001: A pilot study of towards sustainable construction in Malaysia. Procedia Soc. Behav. Sci. 85, 51e60. DOI: 10.1016/j.sbspro.2013.08.337.

Marimon, F., Heras, I. and Casadesús, M., 2009. ISO 9000 and ISO 14000 standards: a projection model for the decline phase. Total Qual. Manage. 20 (1), 1e21. DOI: 10.1080/14783360802614257.

Marimon, F., Llach, J. and Bernardo, M., 2011. Comparative analysis of diffusion of the ISO 14001 standard by sector of activity. J. Clean. Prod. 19, 1734e1744. https://doi.org/10.1016/j.jclepro.2011.06.003.

Mesquida, A.-L. and Mas, A., 2015. Integrating IT service management requirements into the organizational management system. Comp. Stand. Inter. 37, 80e91. DOI: 10.1016/j.csi.2014.06.005.

Mežinska, I., Lapiņa, I. and Mazais, J., 2015. Integrated management systems towards sustainable and socially responsible organisation. Total Quality Management and Business Excellence 26 (5-6), 469e481. DOI: 10.1080/14783363.2013.835899.

Mohammadfam, I., Kamalinia, M., Momeni, M., Golmohammadi, R., Hamidi, Y. and Soltanian, A., 2016. Developing an integrated decision making approach to assess and promote the effectiveness of occupational health and safety management systems. J. Clean. Prod. 127, 119e133. DOI: 10.1016/j.jclepro.2016.03.123.

Neumayer, E. and Perkins, R., 2005. Uneven geographies of organizational practice: explaining the cross-national transfer and diffusion of ISO 9000. Econ. Geogr. 81 (3), 237e259. DOI: 10.1111/j.1944-8287.2005.tb00269.

Omran, A., Bakar, A.H.A. and Sen, T.H., 2008. The implementation of OHSAS 18001 in construction industry in Malaysia. Annals of the Faculty of Engineering Hunedoara- Journal of Enginering VI (3), 157e162. Available at http://annals.fih.upt.ro/pdf-full/2008/ANNALS-2008-3-28.pdf.

Pandi, A.P., Sethupathi, P.V.R. and Jeyathilagar, D., 2016. The IEQMS model for augmenting quality in engineering institutions- an interpretive structural modelling approach. Total Quality Management & Business Excellence 27 (3-4), 292e308. DOI: 10.1080/14783363.2014.978647.

Paas, Õ., Reinhold, K. and Tint, P., 2015. Voluntary safety management system in the manufacturing industry- To what extent does OHSAS 18001 certification help?. Safety of Technogenic Environment 7, 26e34. DOI: 10.1515/ste-2015-0004.

Peixe, B.C.S., Trierweiller, A.C., Bornia, A.C., Tezza, R. and Campos, L.M.S., 2012. Worldwide evolution of ISO 9001 and ISO 14001 certified companies: an exploratory comparative ten-year study. In proceedings of ICIEOM, 9-11 July, Guimarães, Portugal.

Qi, G., Zeng, S., Yin, H. and Lin, H., 2013. ISO and OHSAS certifications- How stakeholders affect corporate decisions on sustainability. Management Decision 51 (10), 1983e2005. DOI: 10.1108/MD-11-2011-0431.

Rajaprasad, S.V.S. and Chalapathi, P.V., 2015. Factors influencing implementation of OHSAS 18001 in Indian construction organizations: Interpretive structural modeling approach. Saf. Health Work 6, 200e205. DOI: 10.1016/j.shaw.2015.04.001.

Ramli, A.A., Watada, J. and Pedrycz, W., 2011. Possibilistic regression analysis of influential factors for occupational health and safety management systems. Saf. Sci. 49, 1110e1117. DOI: 10.1016/j.ssci.2011.02.014.

Robson, L.S., Clarke, J.A., Cullen, K., Bielecky, A., Severin, C., Bigelow, P.L., Irvin, E., Culyer, A. and Mahood, Q., 2007. The effectiveness of occupational health and safety management system interventions: A systematic review. Saf. Sci. 45, 329e353. DOI: 10.1016/j.ssci.2006.07.003.

Röβler, R. and Schlieter, H., 2015. Towards model-based integration of management systems. In proceedings of the 12th International Conference on Wirtschaftsinformatik, 4th-6th March, Osnabrück, Germany, 31e45.

Rueda, R.A.A. and Gómez, G.C.J.P., 2016. Triad of the articulation model of integrated management systems TAM-HSEQ. TECCIENCIA 11 (20), 19e26. DOI: 10.18180/tecciencia.2016.20.3.

Saldaña, M.A.M., Herrero, S.G., Villahoz, J.J.L. and Saiz, R.M.S., 2005. Implantación de sistemas de prevencíon de riesgos en PYMES, acordes con OHSAS 18001. In proceedings of the IX Congreso de Ingeniería de Organización, 8-9 Sep., Gijón, Spain.

Salgado, E.G. and Sampaio, P., 2013. A certificação ISO 9001 no continente americano: análise estatística. In proceedings of ENEP, 08th-11th October, Salvador, Baía, Brazil.

Sampaio, P. and Saraiva, P., 2011. A worldwide analysis of management systems certification. In proceedings of 61st IIE Annual Conference and Expo, 21st-25th May, Reno, Nevada, USA.

Sampaio, P., Saraiva, P. and Domingues, P., 2012. Management systems: Integration or addition?. Int. J. Qual. Reliab. Manag. 29 (4), 402e424. DOI: 10.1108/02656711211224857.

Sampaio, P., Saraiva, P. and Rodrigues, A.G., 2009. An analysis of ISO 9000 data in the world and in the European Union. Total Quality Management and Business Excellence 20 (12), 1303e1320. DOI: 10.1080/14783360903250597.

Sampaio, P., Saraiva, P. and Rodrigues, A.G., 2010. ISO 9001 certification forecasting models. Int. J. Qual. Reliab. Manag. 28 (1), 5e26. DOI: 10.1108/02656711111097526.

Samuel, C. and Munagala, V., 2016. Establishing the baseline for an occupational health and safety management system in a construction company. International Journal of Earth Sciences and Engineering 9 (3), 894e897. Available at http://cafetinnova.org/innova/archiveList/IJEE/2016/03/02090303.htm?paperID=2005.

Samy, G.M., Samy, G.P. and Ammasaiappan, M., 2015. Integrated management systems for better environmental performance and sustainable development- A review. Environmental Engineering and Management Journal 14 (5), 985e1000. Available at http://www.eemj.icpm.tuiasi.ro/pdfs/vol14/no5/3_270_Gopalakrishnan_12.pdf.

Santos, G., Barros, S., Mendes, F. & Lopes, N., 2013. The main benefits associated with health and safety management systems certification in Portuguese small and medium enterprises post quality management system certification. Saf. Sci. 51, 29e36. DOI: 10.1016/j.ssci.2012.06.014.

Saracino, A., Antonioni, G., Spadoni, G., Guglielmi, D., Dottori, E., Flamigni, L., Malagoli, M. and Pacini, V., 2015. Quantitative assessment of occupational safety and health: Application of a general methodology to an Italian multi-utility company. Saf. Sci. 72, 75e82. DOI: 10.1016/j.ssci.2014.08.007.

Savino, M.M. and Batbaatar, E., 2015. Investigating on the resources for integrated management systems within resource-based and contingency perspective in manufacturing firms. J. Clean. Prod. 104, 392e402. DOI: 10.1016/j.jclepro.2015.04.115.

Schönreiter, I., 2016. Process harmonization phase model in post merger integration. In proceedings of the 6th International Symposium on Data-Driven Process Discovery and Analysis SIMPDA 2016, Graz, Austria, 15th-16th December, 3e22.

Silva, S.A., Carvalho, H., Oliveira, M.J., Fialho, T., Soares, C.G. and Jacinto, C., 2017. Organizational practices for learning with work accidents throughout their information cycle. Saf. Sci., in press. DOI: 10.1016/j.ssci.2016.12.016.

Su, H.-C., Dhanorkar, S. and Linderman, K., 2015. A competitive advantage from the implementation timing of ISO management standards. J. Oper. Manag. 37, 31e44. DOI: 10.1016/j.jom.2015.03.004.

Vaughen, B.K., Downes, A., Fox, J. and Belonger, D., 2015. Guidelines for integrating management systems and metrics to improve process safety performance. Process Saf. Prog. 34 (3), 259e266. DOI: 10.1002/prs.11720.

Viadiu, F.M., Fa, M.C. and Saizarbitoria, I.H., 2006. ISO 9000 and ISO 14000 standards: an international diffusion model. Int. J. Oper. Prod. Man. 26 (2), 141e165. DOI: 10.1108/01443570610641648.

Vinodkumar, M.N. and Bhasi, M., 2011. A study on the impact of management system certification on safety management. Saf. Sci. 49, 498e507. DOI: 10.1016/j.ssci.2010.11.009.

Visser, W. and Kymal, C., 2015. Integrated value creation (IVC): Beyond corporate social responsibility (CSR) and creating shared value (CSV). Journal of International Business Ethics 8 (1), 29e43.

Yazdani, A., Neumann, P., Imbeau, D., Bigelow, P., Pagell, M., Theberge, N., Hilbrecht, M. and Wells, R., 2015. How compatible are participatory ergonomics programs with occupational health and safety management systems?. Scand. J. Work Environ. Health 41 (2), 111e123. DOI: 10.5271/sjweh.3467.

Yew, M.H. and Goh, J. C.-L., 2015. An SME's adoption of a cloud based integrated management system (IMS) when certifying against management system standards (MSS). In proceedings of the 26th Australasian Conference on Information Systems, 30th Nov.-4th Dec., Adelaide, Australia.

Zayas, R.A., Karapetrovic, S. and Martínez-Lorente, A.R., 2016. A study of ISO 9001- and ISO 14001- registered service organizations in Murcia. In proceedings of the 19th Toulon-Verona International Conference, 5th-6th September, University of Huelva, Spain, ISBN: 9788890432767, 503e510.

Zeng, S.X., Tam, V.W.Y. and Tam, C.M., 2008. Towards occupational health and safety systems in the construction industry of China. Saf. Sci. 46, 1155e1168. DOI: 10.1016/j.ssci.2007.08.005.

Zimon, D., Gajewska, T. and Bednárová, L., 2016. An influence of quality management system for improvement of logistics distribution. Quality- Access to Success 17 (155), 68e70.