Review

International Occupational Health and Safety Management-Systems Standards as a Frame for the Sustainability: Mapping the Territory

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Received: 29 August 2018; Accepted: 10 October 2018; Published: 12 October 2018

Abstract: A significant part of literature has shown that the adoption of Sustainability and Health-Safety management systems from organizations bears some substantial benefits since such systems (i) create a suitable frame for the sustainable development, implementation and review of the plans and/or processes, necessary to manage occupational health-safety (OHS) in their workplaces and (ii) imply innovative thinking and practices in fields of economics, policy-making, legislation, health and education. To this context, the paper targets at analysing current sustainability and OHSMSs in order to make these issues more comprehend, clear and functional for scholars and practitioners. Therefore, a literature survey has been conducted to map the territory by focusing on two interrelated tasks. The first one includes the presentation of the main International Management Systems (IMS) with focus on Sustainability and OHS (S_OHSMS) topics and the second task depicts a statistical analysis of the literature-review findings (for the years 2006–2017). In particular, the main purposes of the literature research were: (i) the description of key points of OHSMS and sustainability standards, (ii) the comparative analysis of their characteristics, taking into account several settled evaluation-criteria and (iii) the statistical analysis of the survey's findings, while our study's primary aim is the reinforcement of OHSMSs' application in any organization. The results evince, that the field of industry (with 28%) and also of the constructions (with 16%), concentrate the highest percentage of OHSMS use. In general, there were only few publications including OHSMSs (referred to various occupational fields) available in the scientific literature (during 2006–2017) but on the other hand, there was a gradually increasing scientific interest for these standards (especially during 2009–2012).

Keywords: Occupational Health and Safety (OHS); sustainability; Management Standards

1. Introduction

Occupational accidents have a key impact upon human probity, create high expenses for the social health/insurance system of any country and deteriorate the sustainability of societies. Moreover, occupational “health and safety” is one of the most vital issues in any organization (or part thereof) because it assures its continual operation, productivity and efficiency. It is known that any occupational accident or illness can affect both the employee, business operation and overall sustainability performance of firms. These disturbances, which can be valued mainly through the lost

working-hours and the production-delays, can affect the quality of the enterprise's product [1] and the reputation of firms.

To overcome such problems, many organizations have adopted health/safety and sustainability management systems (with sufficient documentation/certification). Any organization is gradually more concerned with improving sustainability and occupational health and safety (OHS) performance and this is achieved by controlling sustainability and OHS risks, in accordance with their sustainability and OHS policy and in the context of strict legislation. There are plenty of organizations that apply sustainability and OHS reviews (or audits) to assess their sustainability and OHS performance. Nevertheless, these reviews and/or audits may not be sufficient to afford an organization with the assurance that its performance will maintain to fulfill the specific legal and policy requirements of this organization. To be efficient, they must be carried out within a structured management system that is embedded in the organization [2].

Moreover, Occupational Health and Safety Management Systems were created after a lot of well-documented and severe industrial-accidents, during the decades of 1970 and 1980 (e.g., the Flixborough Accident in 1974, the Seveso incident in 1976 and the Piper Alpha disaster in 1987). Studies and research applied on these incidents, unveiled deficiencies in main approaches concerning S_OHMS and regulation and revealed the need to approve approaches which thoroughly addressed both education and engineering responses. The propagation of OHS management systems that have been observed globally since the decade of 1990 [3], has noticeably increased the focus on techniques (and/or tools) concerning performance measurement [4].

A Health and Safety Management System provides a framework for managing health and safety risk. Generally speaking, we can consider the term "risk" as the likelihood that someone (or something) will be harmfully affected by the hazard, while "hazard" is any insecure condition (or source of undesirable/adverse events) with strong potential for creating harm or damage. Alternatively, "risk" would be defined as a measure (under ambiguity) of the hazard severity or a measure of the likelihood and consequence of injurious/adverse effects [5–8].

Public interest in the field of risk analysis and assessment (RAA) has been expanded during the last four decades, so that risk analysis constitutes an efficient and widespread procedure that completes the whole management of nearly all aspects of our life. Thus, almost all managers (e.g., of health care, environment, physical infrastructure systems, etc.) incorporate RAA techniques in their decision-making process. In addition, the universal adjustments of risk analysis by many disciplines (like industry, government agencies) in decision-making, have led to a unique development of theory and methodology and also of practical tools [8].

According to P. Marhaviilas [9], risk analysis is a vital process for the safety strategy of any firm, having as main objective the elimination of any potential of damage or harm in its production, while the quantified risk evaluation apparently is the most critical part of the entire procedure of assessing occupational hazards and/or unsafe situations in the workplaces. Furthermore, a complex human-machine system that is composed of humans, machines and their interaction, could suitably be expressed by a system model. Therefore, RAA constitutes a substantial tool for the safety strategy of an organization and also for the assessment process of the occurrence, the consequences and the impact of human activities on systems with hazardous features.

The introduction of a management system in any organization provides a frame for the sustainable development, implementation, sustainability and review of the plans and/or processes which are essential for the occupational health-safety (OHS) management in the workplaces. Since the appearance of such systems during the decade of 1970, significant growth of the approach has occurred, driven by the following factors: (i) OHS is affected by all aspects of the design and functioning of an organization, (ii) the design and management of health and safety systems must associate people, environment and also technical systems in extent that reveal an organization's unique features, (iii) health and safety is a management function and requires broad management involvement, (iv) accidents, injuries and

diseases are an indication of a problem in the system and are not coming from a human error and (vi) performance goals must illustrate management objectives [10].

The international management systems (IMS) standards, covering the field of occupational health and safety (OHS) in worksites, are intended to provide organizations and enterprises with elements of an effective occupational health and safety management system (OHSMS) that can be associated (or integrated) with other management requirements and help organizations achieve OHS and economic objectives.

The S_OHSMS standards specify requirements for an OHS management system, in order to allow an organization to develop and implement a strategy which take into account legal requirements about OHS risks. These are intended to apply to all types of corporations and to establish various geographical, cultural and social conditions. Such a system enables a corporation to create an OHS strategy, develop objectives, scopes and processes to achieve the policy obligations, take action as needed to improve its performance and demonstrate the compliance of the system to the requirements of this OHSMS standard. Moreover, the general aim of OHSMS standards is to support capable OHS practices, in the framework of socio-economic needs [2].

The British Safety Council (BSC) and the International Labour Organisation (ILO) made a research in which valued the rewards of the prevention of accidents and/or diseases in enterprises within a period of 2 years. This study shows that the corporation which had adopted such a safety management system had the following results [11]: (i) productivity improvement, (ii) significant reduction of the frequency of cases of absence, (iii) significant reduction of compensation claims and insurance costs, (iv) improvement of the psychology of labor in addition with the increase of morale and concentration at work and (v) improving the company image to customers and suppliers.

In this work, the foremost IMS standards of promoting sustainability and OHS are presented, on the one hand and on the other side, the statistical results of a research (literature survey), reviewing vicarious scientific journals (for years 2006–2017). Thus, the main aim of our study is the strengthening of OHSM standards' application, in any organization (i.e., of any type and size).

The rest of the paper consists of five sections including (i) an overview of the OHSMS standards, (ii) a methodology (iii) the results of a statistical analysis, (v) the discussion and (vi) the conclusions.

2. Theoretical Background

A significant part of literature focuses on RAA of sustainability and health/safety accidents. The growing complexity of services, processes and products, entering the market, requires that the safety aspects must be considered with high priority. Undoubtedly, there is no absolute safety, so that some risk always remains in a specific worksite, constituting the “residual risk.” Thus, any service, process and/or product can only be relatively safe. To continue, relative safety is achieved by risk degradation to a tolerable level, which is called as “tolerable risk,” which is defined by the exploration of the finest balance between the ideal safety and the demands to be met by a service/process/product and factors such as profit for the user and cost effectiveness. Tolerable risk is succeeded by the procedure of risk assessment (risk analysis and risk evaluation) and risk reduction [12], while “risk management” can be considered as the entire methodology that includes both “qualitative” and “quantitative analysis techniques” [13–15].

In the scientific literature, four phases are prominent, as far as quantitative risk assessment is concerned (see for example the works [9,16–18]) depicted as follows: (a) Qualitative analysis, that incorporates the system definition and its scope, the hazards identification/description and the failure scenarios as well. (ii) Quantitative analysis, which incorporates the probabilities determination and the consequences of the defined undesirable events and also the risk quantification by a number (i.e., the risk quantity) or by a graph as a function of probabilities and consequences. (iii) Risk evaluation, which incorporates the evaluation process, on the base of the results of the former analysis. (iv) Risk control and reduction phase, which includes the step of taking measures (in order to be reduced the

risk) and taking into account how the risks can be controlled (for example by inspection, maintenance or warning systems).

According to the IEC [15] the concept of risk presents two components that is, the frequency (or probability) that a harmful event (or an unsafe situation) is expected to occur and the consequences of this event. Moreover, CCPS [19] determines the risk as a measure of economic loss or human hurt in the frame of the likelihood and the magnitude of the loss (or damage).

To eliminate risks from sustainability and Health and Safety problems, a number of management systems has been proposed. In general, a management system is the methodology or the way by which an organization manages its internal procedures (or subjects) in order to achieve its objectives, which are associated with a number of different topics (including service quality or product quality, operational capability, environmental accomplishment, health and safety in the workplaces, et cetera). The level of the system's intricacy will depend on each organization's specific context. In small organisations, there is no (or less) need for extensive documentation because it is transparent how the employees contribute to the organization's overall aims. On the other side, more complicated corporations operating, may need extensive documentation in order to accomplish their organizational goals. Moreover, international management system (IMS) standards help organizations improve their performance by specifying repeatable steps that organizations consciously implement to accomplish their aims and to develop an organizational culture [20].

According to Gallagher [21], OHSMS systems have been defined as "a combination of the planning and review, the management organizational arrangements, the consultative arrangements and the specific program elements that work together in an integrated way to improve health and safety performance."

Table 1 presents an overview of the most important worldwide OHSMS standards, based on selected information that has been collected from various sources and from the review of scientific literature as well.

Table 1. An overview of OHSMS standards.

Codes	Edition Year	Institutions	Description	Focus	Reference
BS 8800	1996 (as BS 8800:1996) and revised in 2004 (as BS 8800:2004) and in 2008 (as BS 18004:2008).	BSI	"It gives guidance on OHS management systems for assisting compliance with stated OHS policies and objectives and on how OHS should be integrated within the organization's overall management system"	Social dimension	[22–24]
HSG 65	1991 and revised in the years 1997 and 2013.	HSE	"A useful guide for directors, managers, health/safety professionals and employee representatives who wanted to improve health and safety in their organizations"	Social dimension	[25,26]
OHSAS 18001	The first edition (OHSAS 18001:1999) has been technically revised and replaced by the OHSAS 18001:2007 edition (second one).	44 cooperating organizations (constituting OHSAS Project Group)	"It is based on (i) "Plan": establish the aims and processes which are essential for the achievement in accordance with the organization's OHS policy, (ii) "Do": implement the processes, (iii) "Check": monitor and measure processes against OHS policy, objectives, legal and other requirements and report the results, (iii) "Act": take actions to continually improve OHS performance"	Social dimension	[2]
ILO-OSH 2001	2001 and revised in 2009.	ILO	"It provides a unique and powerful instrument for the development of a sustainable safety culture within organizations. The practical recommendations of these guidelines are intended for use by all those who have responsibility for occupational safety and health management"	Social dimension	[27]

Table 1. Cont.

Codes	Edition Year	Institutions	Description	Focus	Reference
AS/NZS 4801:2001	2001	AS/NZS	"The scope of this standard is to set auditable criteria for an OHSMS. It is a specification that aims to cover the best elements of such systems already widely used in New Zealand and Australia. It incorporates guidance on how those criteria may be accomplished"	Social dimension	[28]
ANSI/ AIHA Z10-2005	2005 and revised in 2012	ANSI	"Significant features that define Z10 include focus on management leadership roles, efficient employee participation, design review and change. It provides a tool to help organizations create and develop OHS performance"	Social dimension	[29,30]
SS 506	2004 (as SS 506:2004) and revised in 2009 (as SS 506:2009).	SSC	"It is consisted of three parts: (i) Requirements, (ii) Guidelines for the implementation of SS 506, (iii) Requirements for the chemical industry. It designates requirements for an OSH management system to activate a company to develop and implement a strategy and scopes which take into account legal requirements and information about OSH risks"	Social dimension	[31,32]
Une 81900:1996 EX	1996	AENOR	<ul style="list-style-type: none"> - UNE 81900:1996 EX: Prevention of Occupational Hazards. Rules for the implementation of a SGPR. - UNE 81901:1996 EX: Prevention of Occupational Hazards. General Rules for the Evaluation of SGPRs. - UNE 81902:1996 EX: Prevention of Occupational Hazards. Vocabulary. - BUNE 81903:1997 EX: Prevention of Occupational Hazards. General Rules for the Evaluation of a SGPR. Criteria for the qualification of the Auditors of Prevention. - UNE 81904:1997 EX: Prevention of Occupational Hazards. General Rules for the Evaluation of SGPRs. Management of audit programs. - UNE 81905:1997 EX: Prevention of Occupational Hazards. Guide for the implementation of a SGPR" 	Social dimension	[33]
Uni 10616	1997 (and withdrawn in 2012)	UNI	"Some of the major qualifying points are: (i) Espousal of inherent safety principles. (ii) Espousal of matrices or risk charts for assessing the acceptability / tolerability of risks. (iii) Definition of inspection activities and periodic checks of critical lines and equipment. (iv) The assessment of the external domino effect between neighbouring plants, (v) The adoption of a work-permission system, (vi) Selection of suppliers of goods and services such as companies, companies, builders, consortia, (vii) Adopting procedures for periodic internal auditing with internal or external auditors"	Social dimension	[34]

Table 1. Cont.

Codes	Edition Year	Institutions	Description	Focus	Reference
ISO 14000	ISO 14001:2004	ISO	"The ISO 14000 family of standards emphasize on manage their environmental responsibilities. In particular, ISO 14001:2015 and its accompanying standards such as ISO 14006:2011 concentrate on environmental systems to achieve this"	Environmental dimension	[35]
ISO 45001	2018	ISO	"ISO 45001 is intended for use by any organization, regardless of its size or the nature of its work and can be integrated into other health and safety programmes such as worker wellness and wellbeing. It can assist an organization to conform its legal requirements"	Social dimension	[36,37]

Over the past three decades, the use of OHSMS has become common in worksites in the developed economies, noting the fundamental elements of a OHSMS [38]. It is worth noting that many international management system standards have contiguous structure, containing a large number of the same terms and definitions. These characteristics are helpful for those organizations that operate an "integrated" management system [20] which can merge the requirements of two or more management system standards simultaneously (for example OHS with Environmental, or OHS with Quality management systems).

In Table 2 we depict the evolution of the OHSMS standards throughout the years 1990–2018. More specifically, the symbols "–" denote (in association with the year) the nonexistence of a standard, while the symbols "+" the appearance of the standard. In addition, the symbols "++," "+++", "++++" and "+++++", denote the 1st, the 2nd, the 3rd and the 4th update of it, correspondingly.

Table 2. The evolution of the OHSMS standards throughout the years 1990–2018.

Year	ISO 14001	ILOOSH 2001	BS 8800	OHSAS 18001	HSG65	ANSI/AIHA Z10	AS/NZS 4801	SS 506	Une 81900	Uni 10616	ISO 45001
1990	–	–	–	–	–	–	–	–	–	–	–
1991	–	–	–	–	+	–	–	–	–	–	–
1992	+	–	–	–	+	–	–	–	–	–	–
1993	+	–	–	–	+	–	–	–	–	–	–
1994	+	–	–	–	+	–	–	–	–	–	–
1995	++	–	–	–	+	–	–	–	–	–	–
1996	+++	–	+	–	+	–	–	–	+	–	–
1997	+++	–	+	–	++	–	–	–	+	+	–
1998	+++	–	+	–	++	–	–	–	+	+	–
1999	+++	–	+	+	++	–	+	–	+	+	–
2000	+++	–	+	+	++	–	++	–	+	+	–
2001	+++	+	+	+	++	–	+++	–	+	+	–
2002	+++	+	+	+	++	–	+++	–	–	+	–
2003	+++	+	+	+	++	–	+++	–	–	+	–
2004	++++	+	++	+	++	–	+++	+	–	+	–
2005	++++	+	++	+	++	+	+++	+	–	+	–
2006	++++	+	++	+	++	+	+++	+	–	+	–
2007	++++	+	++	++	++	+	+++	+	–	+	–
2008	++++	+	+++	++	++	+	+++	+	–	+	–
2009	++++	++	+++	++	++	+	+++	++	–	+	–
2010	++++	++	+++	++	++	+	+++	++	–	+	–
2011	++++	++	+++	++	++	+	+++	++	–	+	–
2012	++++	++	+++	++	++	++	+++	++	–	–	–
2013	++++	++	+++	++	+++	++	+++	++	–	–	–
2014	++++	++	+++	++	+++	++	+++	++	–	–	–
2015	++++	++	+++	++	+++	++	+++	++	–	–	–
2016	++++	++	+++	++	+++	++	+++	++	–	–	–
2017	++++	++	+++	++	+++	++	+++	++	–	–	–
2018	++++	++	+++	++	+++	++	+++	++	–	–	+

Annotations: the symbols "–," "+," "++," "+++", "++++" and "+++++", denote the nonexistence, the appearance, the 1st, the 2nd, the 3rd and the 4th update of a standard, respectively.

3. Methodology

Today, OHS issues are considered very important for organizations for economic (e.g., decrease lost working days), environmental (e.g., environmental hazards for employees) and social issues (e.g., ethical working conditions). It is well known that the major body of relevant literature focuses on the regulatory requirements of organizations regarding OHS issues, while a smaller part of the literature emphasizes on voluntary initiatives of organization on OHS issues. However, the voluntary trend of organizations has lately gained ground under the context of social responsibility of organizations to contribute to sustainable development [39]. This is integrated into the context of organizations as a commitment to OHS issues beyond the law which should be achieved through voluntary implementation of OHS standards (e.g., OSHAS 18001, ISO 45001). To this end, the suggested research methodology recommends sustainability concept as a frame to examine a set of current OHS standards (Table 1) through: (a) environmental dimension of sustainability (ISO 14001) and (b) social dimension of sustainability (BS 8800; HSG 65; OHSAS 18001; ILO-OSH 2001; ASINZS 4801; SS506; Une 81900: 1996 EX; Uni10616 and ISO 45001). It is necessary to clarify that the sustainability concept is only utilized as a frame of analysis and classification of OHS standards and none effort has been made to explain how the OHS examined standards contribute to aspects of sustainable development.

Additionally, the suggested research methodology is based on three sequential steps. The first step pertains the selection of journals, the second includes the appropriate keywords for addressing research questions and the third shows the coding method. In particular, the review of the scientific literature was accomplished by the research of ten representative scientific journals which focus on sustainability and health and safety issues (Table 3). The selection of these papers was based on the following two criteria: (a) the focusing on health and safety issues and sustainability and (b) the existence of high impact among scholars (Q1 and high impact factor). More specifically, taking into account that few other systematic (e.g., [3]) or narrative (e.g., [40–43]) literature reviews exist, on the topic of OHSMS standards, the time period before the year 2006, we investigated and studied published articles of the previous referred journals, collecting a large number of around N = 9822 papers, throughout the years 2006–2017.

Table 3. The ten investigated journals/sources (throughout the years 2006–2017).

Nr	Source	Publisher
1	"Applied Ergonomics"	"Elsevier B.V."
2	"Accident Analysis and Prevention"	
3	"Journal of Cleaner Production"	
4	"Journal of Operations Management"	
5	"Safety Science"	
6	"Journal of Loss Prevention in the Process Industries"	
7	"International Journal of Industrial Ergonomics"	
8	"Journal of Safety Research"	
9	"Architectural Science Review"	"Taylor & Francis"
10	"Professional Safety"	"American Society of Safety Engineers"

In particular, the methodological steps of the survey included: (i) investigation of the literature (e.g., through SCOPUS); (ii) screening the journals with the highest number of articles and the most important studies on S_OHSMS standards; (iii) selection of relevant studies; (iv) appraisal of the quality of the research evidence in the studies. The appropriate keywords we used in the survey were "Occupational Health and Safety", "Sustainability", "Management Standards".

4. Results

The procedure of reviewing the scientific literature, unveiled only a few published papers on OHSMS standards referred to many different fields (like construction, industry, engineering,

transportation, chemistry, oil and refinery, food sector, et cetera). These papers address concepts, tools and methodologies that have been created and practiced in such areas as design, development, quality-control and maintenance, in association with occupational risk assessment.

The different OHSMS standards follow, in general, similar paths between “start” and “finish.” Taking into account the results of our literature review, we present in the following Table 4, the comparison between the above referred OHSMS standards. This table depicts an overview of their features, comparatively with several settled evaluation-criteria.

Table 4. Comparison of OHSMS Standards.

Characteristics	OHSMS Standards							
	ISO 14001	ILOOSH 2001	BS 8800	OHSAS 18001	HSG65	ANSI/AIHA Z10	AS/NZS 4801	SS 506
General requirements	YES	NO	NO	YES	NO	NO	NO	NO
Initial or periodic status review	NO	NO	YES	NO	YES	NO	NO	NO
Management leadership and Labour participation	NO	NO	NO	NO	NO	YES	NO	NO
Policy	YES	YES	YES	YES	YES	NO	YES	YES
Organising	NO	YES	YES	NO	YES	NO	NO	NO
Planning	YES	YES	YES	YES	YES	YES	YES	YES
Implementation/Operation	YES	YES	YES	YES	YES	YES	YES	YES
Inspection and Evaluation	YES	YES	NO	YES	NO	YES	YES	YES
Performance measurement	NO	NO	YES	NO	YES	NO	YES	NO
Improvement actions	NO	YES	NO	NO	NO	NO	NO	NO
Corrective actions	YES	NO	NO	YES	NO	YES	NO	YES
Management Review	YES	NO	NO	YES	YES	YES	YES	YES
Audit	NO	NO	YES	NO	YES	NO	NO	NO
Continuous Improvement	YES	NO	NO	YES	NO	YES	YES	YES
Performance inspection	YES	YES	YES	YES	YES	YES	YES	YES
Origin	International	International	UK	International	UK	USA	Australia/ New Zealand	Singapore
Year of establishment	1992	2001	1996	1999	1991	2005	1999	2004
Update	YES	YES	YES	YES	YES	YES	YES	YES
Good embedded OHS practices	NO	YES	YES	YES	NO	YES	NO	YES
Weak issues	YES	YES	YES	YES	YES	YES	YES	YES
Glossary Terms and definitions	YES	YES	YES	YES	NO	NO	NO	NO
Workers participation	NO	YES	NO	NO	NO	NO	NO	NO
Documentation	YES	YES	YES	YES	YES	YES	YES	YES
Free of Charge Manual	NO	YES	NO	NO	NO	NO	NO	NO
Risk assessment technique	NO	NO	YES	YES	NO	YES	NO	NO
Application on Organisations of any type and size	NO	YES	YES	YES	NO	YES	NO	YES

Table 4. Cont.

Characteristics	OHSMS Standards							
	ISO 14001	ILOOSH 2001	BS 8800	OHSAS 18001	HSG65	ANSI/AIHA Z10	AS/NZS 4801	SS 506
Accompanied with extra guidelines series	NO	NO	YES	YES	NO	NO	YES	YES
Incorporated examples	NO	NO	YES	NO	NO	YES	NO	NO
Annexes	YES	YES	YES	YES	YES	YES	YES	YES
Embedded comparisons with other OHSMS standards	NO	NO	YES	YES	NO	YES	NO	NO
Possible combination with other OHSMS standards	NO	NO	YES	YES	NO	YES	NO	NO
Compatibility with other OHSMS standards	YES	YES	YES	YES	NO	YES	NO	NO
Compatibility with Quality and/or Environmental IMS standards	YES	NO	YES	YES	YES	YES	YES	YES
Future improvement	YES	YES	YES	YES	YES	YES	YES	YES
Taking into account recent legislative changes	NO	NO	YES	NO	NO	NO	NO	NO

The investigation of the scientific literature revealed $S = 75$ published technical articles which were associated with OHSMS Standards in the worksites and concerned many different fields (like construction, chemistry, engineering, transportation, medicine, etc.).

In Appendix A (Table A1) we show the classification results of the 75 articles incorporating OHSMS standards which were defined by the investigation of $N = 9822$ papers of ten sources covering the time period 2006–2017. Table A1 uses eight columns for example, the number (or numerical code) of the paper (A), the paper's citation information (columns B, C, D), the OHSMS standard's name (E), the kind of the paper's data or material (F), the field of application (G) and the source (journal's name) [column H].

In Appendix B (Table A2) we illustrate the statistical results of the survey including the following:

- the absolute frequency N_i that is, the number of investigated papers per journal (col. C, that is, **JAE**: 886; **AAP**: 1522; **JCP**: 1005; **JOM**: 995; **ASR**: 1007; **JSS**: 945; **JPS**: 998; **JLPPI**: 881; **IJIE**: 955; **JSR**: 628),
- the relative frequency $F_i = N_i/N$ of the ten journals, concerning the total amount of the published papers during 2006–2017 (column D, that is, **JAE**: 9.02%; **AAP**: 15.50%; **JCP**: 10.23%; **JOM**: 10.13%; **ASR**: 10.25%; **JSS**: 9.62%; **JPS**: 10.16%; **JLPPI**: 8.97%; **IJIE**: 9.72%; **JSR**: 6.39%),
- the number of papers $n_{ST(i)}$ concerning OHS which include or use or refer to OHSMS standards (column E, that is, **JAE**: 3; **AAP**: 8; **JCP**: 3; **JOM**: 1; **ASR**: 1; **JSS**: 40; **JPS**: 4; **JLPPI**: 8; **IJIE**: 1; **JSR**: 6),
- the relative occurrence frequency of papers (referred to N) which include (or use or refer to) OHSMS-standards $f_{ST(i)} = n_{ST(i)}/N$ (column F, that is, **JAE**: 0.03%; **AAP**: 0.08%; **JCP**: 0.03%; **JOM**: 0.01%; **ASR**: 0.01%; **JSS**: 0.41%; **JPS**: 0.04%; **JLPPI**: 0.08%; **IJIE**: 0.01%; **JSR**: 0.06%),
- the normalized (per journal) occurrence frequency of papers which include OHSMS standards $f_i^* = n_{ST(i)}/N_i$ (column G, that is, **JAE**: 0.34%; **AAP**: 0.53%; **JCP**: 0.30%; **JOM**: 0.10%; **ASR**: 0.10%; **JSS**: 4.23%; **JPS**: 0.40%; **JLPPI**: 0.91%; **IJIE**: 0.10%; **JSR**: 0.96%),

- (vi) the relative occurrence frequency of papers (referred to S) which include OHSMS standards $f^{**}_{ST(i)} = n_{ST(i)}/S$ (column F, that is, **JAE**: 4.00%; **AAP**: 10.67%; **JCP**: 4.00%; **JOM**: 1.33%; **ASR**: 1.33%; **JSS**: 53.33%; **JPS**: 5.33%; **JLPPI**: 10.67%; **IJIE**: 1.33%; **JSR**: 8.00%).

Moreover, Figure 1 illustrates for the time period of 2006–2017 the following: (a) the relative frequency $F_i = N_i/N$ of the ten journals, concerning the total amount of their published articles, (b) the relative occurrence frequency of papers (referred to N) with OHSMS-standards $f_{ST(i)} = n_{ST(i)}/N$, (c) the normalized (per journal) occurrence frequency of papers concerning OHS which include OHSMS standards $f_i^* = n_{ST(i)}/N_i$ (d) the relative occurrence frequency of papers (referred to S) which include OHSMS standards $f^{**}_{ST(i)} = n_{ST(i)}/S$, (e) the relative occurrence-frequency of the various OHSMS standards (which are included in the above referred $S = 75$ papers) and (f) the percentage distribution of the papers with OHSMS standards in association with different types of data.

Figure 1. Cont.

(c)

(d)

(e)

Figure 1. Cont.

Figure 1. It depicts for the period of 2006–2017 the various relative occurrence frequencies of papers with OHSMS-standards.

The survey relating to the above 10 journals revealed (according to Appendix B, Table A2) that the papers concerning OHS and including OHSMS standards were very few (i.e., for JAE the maximum percentage is only 0.34% taking into account the total number N of the investigated papers and only ~4% as far as the normalized per journal percentage is concerned), while the majority (i.e., 99.24%) is represented by papers without OHSMS standards. Taking into account the graphs of Figure 1, we note that although AAP is the journal with the most publications for 2006–2017 (Figure 1a), JSS is the journal with the greatest number of publications, concerning OHSMS standards (Figure 1b–d).

Besides, the pie-chart of Figure 1e reveals that the OHSAS 18001 standard, presents the higher relative occurrence-frequency (47.06%) in comparison with the other OHSMS standards (of Table A2 in Appendix B), that is, OHSAS 18001 is the most frequent OHSMS standard according to scientific literature review. This can be related with the fact that this international standard was the result of the co-operation of 13 different international organizations which represent 80% of the certification bodies.

In addition, the graph 1f which depicts the percentage distribution of the articles (with OHSMS standards) shows that “Empirical/Qualitative” is the most frequent type compared with various types of data.

In Figure 2 we illustrate the yearly variation of the number (nST) of papers with OHSMS standards, published by the previous referred 10 journals, during 2006–2017 (panel a) and the corresponding percentage distribution of papers in association with the year of publication (panel b). The inserted bar-graph in panel a, depicts the relative occurrence frequency of papers concerning OHS which include OHSMS standards in association with the title of the 10 journals (horizontal axis).

The curve of the graph of Figure 2a shows the existence of a long-term trend factor with positive inclination (throughout the period 2007–2012), with negative inclination (for the period 2013–2015) and also with a positive inclination (throughout the 2016–2017). In particular, there is a gradual increasing for the period 2006–2012 (with a maximum in years 2011 and 2012), while for the years 2013–2015, an abrupt decreasing with an intensive negative slope. The second graph (pie-chart) shows that 2011 and 2012 are the years with the greatest percentage of papers referring to OHSMS systems.

To continue, the pie-chart of Figure 3 displays the distribution of papers with OHSMS standards (published by the 10 journals during 2006–2017) in association with various fields of application (Industrial Sector: 28%; Construction Sector: 16%; Chemical Sector: 6.67%; Oil and Refinery: 4%; Mining: 4%; Shipbuilding Sector: 4%; Food Sector: 4%; Railways Sector: 2.67%; Transportations Sector: 1.33%; Telecommunications: 1.33%; Other: 28%). The major evident feature of this pie-chart is that the field of “Industry” concentrates the maximum number of the papers with OHSMS standards.

Apparently, one reason is that the industrial organizations present more dangerous working conditions in comparison with other corporations (for example due to the existence of heavy machines in the production procedure) [9,44]. Moreover, it is apparent that the construction sector is following, due to the greatest number of occurring incidents.

Figure 2. (a) The curve illustrates the variation of the number of papers with OHSMS standards published by the 10 journals during 2006–2017. (b) Distribution of papers with OHSMS standards in association with the year of publication.

Figure 3. The pie-chart displays the distribution of papers with OHSMS standards (published by the 10 journals during 2006–2017) in association with the various fields of application.

5. Discussion

Taking into account that nearly 2.3 million of people die per year due to work-related accidents and/or diseases, occupational injuries and/or illnesses are significantly adverse for the employers and also for the state's economy, resulting in losses from early retirements, the staff absences and the high insurance costs [45,46]. Thus, occupational health/safety aspects represent some of the most crucial subjects of the social policy in the EU and as a consequence the Lisbon strategy was adopted for growth and employment, which aims to create jobs with care in health and safety for the employees.

Over the past three decades the use of Occupational Health and Safety Management Systems (OHSMS) has expanded in the workplaces of developed economies and their growing usage could be attributed to many reasons and factors. In particular, OHSMSs embody the principles of “continuous improvement” or “quality management” which have been used and applied by enterprises for improved business competitiveness. Taking into account that the principles of OHSMS are similar to

methods such as Total Quality Management, it is presumable that experience with TQM has formed a basis for new applications of removing occupational hazards and improving safety awareness [47].

OHSMS differ as far as the miscellaneous techniques of implementation are concerned. According to Frick and Wren [40] there are three types of implementation, that is, voluntary, mandatory and hybrid. The first one exists when companies affiliate OHSMS on their own volition. On the other hand, mandatory systems have been enforced in many European countries (for example in Denmark and Norway) where the state's legislation requires establishment of a RAA system. Quasimandatory methodologies may also exist in case of external commercial requirements which take the form of legislative demands. Thus, many organizations settle OHSMS to comply with the demands of customers and suppliers, principal contractors and other commercial bodies. Hybrid methods require an admixture of voluntary motives and legislative requirements [47]. It is worth noting that, only a fraction of all employers and/or organisations have introduced what it is called as OHS management systems (such as OHSAS 18001) [2]. Yet, within the EU, California (USA) and in many other countries, employers are required by regulation mandated to organise a systematic OHS management (in the EU according to the Framework Directive of 89/391/EEC).

Compliance with these regulations will result in an effective prevention of OHS risks, even without introducing OHSAS or any other voluntary OHS management system. Some other distinctions that should be underlined are the following:

- (i) The term "systematic" in mandatory systematic OHSM is not at all the same as the term "system" in voluntary OHSM systems. This means that the UK's HSG 65 is quite different from the other described "systems." HSG 65 constitutes guidelines (best practice) for how to comply with the mandatory regulation of systematic OHSM (transposing of EU directive 89/391/EEC into UK legislation) while all the other listed "systems" are voluntary and more or less commercial products (which still can be very useful).
- (ii) Regulated mandatory systematic OHSM is not at all identical to voluntary OHSM standards. This article aims to cover both of them. In any case both mandatory OHSM (such as in all of the EU, since 1989, through 89/391/EEC but also in many other states, for example, in California since 1991) and the much more complex commercial products of voluntary OHSM systems (such as OHSAS 18001) are critically discussed and distinguished.
- (iii) The term "Standard" is also a term with importantly different meanings. In Anglo-saxon countries this is often the same as a regulation but a voluntary standard (such as ISO) is (by definition) not a regulation.

The implementation and application of a range of efficient OHS management actions systematically, can contribute to optimal results for all interested parties. Organizations of all types establish a systematic process to manage OHS and develop OHSMS systems within the context of (i) the general growth of concern from all interested parties about OHS, (ii) changes to legislation and (iii) other measures to foster sustained OHS improvement. There are many reasons for organizations to develop OHSMSs (for example legal imperatives, ethical concerns, industrial considerations, financial performance improvement, etc.). Implementation of an efficient OHSMS will create a reduction of workplace illnesses and injuries, minimizing the expenses associated with accidents [28]. Consequently, the application of OHSMS standards provides a unique instrument for the development of a sustainable safety culture within enterprises. Besides, human factors (including the culture, politics, etc.) within organizations can make or break the effectiveness of any management system and needs to be considered very carefully when implementing a management system [22]. An OHSMS standard specifies requirements in order to help any enterprise to formulate a strategy taking into account legislation and information about risks and/or harm. It applies to those hazards over which the organization may exert control and over which it can be expected to have an influence [28].

Other standards (like ISO 31000, IEC31010) constitute an introduction to selected techniques and compare their possible applications, benefits and limitations. They also provide references to sources of more detailed information.

With the globalization of the economy and the success of Quality Management Systems (QMS) and of Environmental Management Systems (EMS), organizations require a simple, integrated and also a global management system. For this reason, and due to the lack of a model for an OHS management system that has been accepted worldwide, systems or models, guides or norms of the OHS management, have been propagated throughout the world.

Previous investigations have recognized a research gap, as far as the studies of the reliability and validity of OHSMS standards, are concerned [48]. In this study, the most considerable OHSMS standards created at the international level, are presented and analysed at their updated version. In other words, our article introduces different standardized occupational and safety management systems (guidelines), which are commonly used internationally. In particular, the purpose of this work is to collect important information regarding the use of OHSMS standards by achieving a scientific literature investigation of vicarious journals (published by Elsevier B.V., Taylor & Francis and the American Society of Safety Engineers) covering the time period of 2006–2017. This is an interesting topic which combines academic papers and practically used standards. Subsequently, the main aims of this exploratory study are: (i) the depiction of commercial and industrial trends, as far as the OHSMS standards are concerned, (ii) the implementation of these standards and (iii) the reinforcement of their application in the worksites of organizations.

It is worth mentioning that, few other systematic literature reviews (like the one of Robson et al. [3]) or narrative reviews (e.g., [40–43]) exist, concentrating on the topic of OHSMS standards and concerning the years before 2006. So this is the reason for conducting our review throughout the years 2006–2017. In addition, the literature overview of Li and Guldenmund [49] has a different aim and describes safety management systems (SMSs) as far as the SMSs models are concerned, that is, accident-related models and organizational models.

The methodological steps of the survey included: (i) research of the literature; (ii) screening the journals with the most important studies on S_OHSMS standards; (iii) selection of relevant studies; (iv) appraisal of the quality of the research evidence in the studies.

The review unveils the following:

- There are only a few publications including OHSMS standards (during 2006–2017), which are referred to a variety of occupational fields (like construction, industry, engineering, transportation, chemistry, oil and refinery, et cetera).
- These papers address techniques that have been emerged in areas such as design/development, quality-control and maintenance, as far as occupational risk assessment is concerned.
- “Safety Science” (SS) and “Journal of Loss Prevention in the Process Industries” (JLPPI) are the scientific journals which published (during 2006–2017) the most scientific papers concerning OHSMS.
- The sector of “Industry” (with 28%) and also the “Construction” (with 16%), accounted for the highest percentage, as far as the usage of OHSMS standards is concerned, presumably because their work conditions are more unstable and dangerous in comparison with other occupational sectors (e.g., telecommunications). In addition, these sectors are very hazardous worldwide, owing to their unique dynamic nature, poor conditions and tough environment [44,50].
- The comparison between the previous presented OHSMS standards (in Table 4), depicts an overview of their features, comparatively with various developed evaluation-criteria.
- The OHSAS 18001 standard, presents the higher relative occurrence-frequency (48%) in comparison with the other OHSMS standards, due to the fact that this international standard was produced by the co-operation of 13 different international organizations which represent 80% of the certification bodies.

- The percentage distribution of the papers (with OHSMS standards) reveals that “Empirical/Qualitative” is the most frequent type compared with other types of data.
- Our selected graphs, show (for the distribution of the publications with OHSMS standards) the existence of a long-term trend factor with positive inclination (during 2007–2012), with negative inclination (during 2013–2015) and also with a positive inclination (throughout the 2016–2017).
- In general, there is an increasing scientific interest for OHSMS standards, especially in period 2009–2012.
- The entire objective of the usage of OHSMS standards is to support and promote efficient OHS practices, in balance with socio-economic requirements [2].
- The OHSMS standards are not legally binding and have not got the intention to replace national laws or regulations and/or accepted standards.
- OHSMS have been proposed as a way to reduce injuries and illnesses for businesses of all types and sizes [51,52].
- The various OHSMS standards have common basic requirements and features but they are implemented in different processes. Besides, the different OHSMS standards follow, in general, similar paths between “start” and “finish.”
- Many organizations apply an “integrated” management system which combines the requirements of two or more management system standards simultaneously (for example OHSMS with Environmental, or OHSMS with Quality management systems standards).

6. Conclusions

Governments, employers and workers recognize, day after day, the positive impact of introducing S_OSHMS standards at the organization level, both on the reduction of hazards/risks and also on productivity. In particular the benefits of effective S_OSHMS standards to any commercial body or enterprise include: (i) more effective usage of resources, (ii) improved financial performance, (iii) improved risk management and (iv) increased capability to deliver consistent and improved services and products. OHSMS standards are not intended to replace national laws, regulations or accepted standards but on the other side, their main aim is to support and promote efficient OHS practices, in balance with socio-economic requirements.

Using the previous analysis and its main outcomes, the next dominant conclusions can be extracted:

- The application of OHSMS standards is not significantly extended in organizations and the knowledge about them has not been fully shared and expanded among the miscellaneous scientific fields, so we have the opinion, that the scientific community, have to transfer the similarities from one field to another.
- The implementation of a “integrated” management systems which combine the requirements of two or more management system standards simultaneously (for example OHSMS with Environmental, or OHSMS with Quality management systems standards) would enable organizations to achieve efficient results on the reduction of risks and also on productivity.
- OHSMS standards can be developed and implemented by organizations of any type and any size (large or small).
- As this study is not an empirical research but a review, the value of the article rests on clear distinctions, definitions and analysis. Moreover this exploratory study, provides a rich description for the usage of OHSMS standards in workplaces and lays the background for further research into the reliability and reinforcement of their application in any organization.

As a general conclusion, our literature survey shows that: (i) only a small number of published articles focusing on OHSMS standards (and concerning miscellaneous occupational fields) are available for the period of years 2006–2017 and (ii) the scientific community expanded its interest for the usage of OHSMS standards, during the years of 2009–2012.

Author Contributions: Conceptualization, P.M., D.K., I.N.; Data curation, P.M., S.T.; Formal analysis, P.M., D.K.; Funding acquisition, I.N.; Investigation, P.M., D.K.; Methodology, P.M., D.K., I.N.; Writing—original draft, P.M.; Writing—review & editing, P.M., D.K., I.N.

Conflicts of Interest: We declare no conflict of interest.

Abbreviations and Acronyms

ANSI	American National Standardization Institute
JAE	Applied Ergonomics
ASR	Architectural Science Review
AENOR	Asociación Española de Normalización/Certificación (Spanish Assoc. for Standards)
AS/NZS	Australian/New Zealand Standard
BSI	British Standards Institution
BSC	British Safety Council
CPQRA	Chemical Process Quantitative Risk Analysis
CCPS	left for Chemical Process Safety
UNI	Ente Nazionale Italiano di Unificazione (Italian National Unification)
EMS	Environmental Management Systems
HSE	Health and Safety Executive
IEC	International Electrotechnical Commission
IJIE	International Journal of Industrial Ergonomics
ILO	International Labour Organization
IMS	International Management Systems
ISO	International Organization for Standardization
JCP	Journal of Cleaner Production
JLPPI	Journal of Loss Prevention in the Process Industries
JOM	Journal of Operations Management
JSR	Journal of Safety Research
OHSAS	Occupational Health and Safety Assessment Series
OHSMS	Occupational health and safety management system
OHS	Occupational health-safety
JPS	Professional Safety
QMS	Quality Management Systems
RAA	Risk analysis and assessment
JSS	Safety Science
SSC	Singapore Standards Council
S_OHSMS	Sustainability and Occupational Health and Safety Management Systems
TQM	Total Quality Management

Appendix A

Table A1 presents the classification results of 75 papers [3,51,53–125] which are associated with OHSMS standards, covering the period of 2006–2017.

Table A1. The classification results of the 75 papers.

A/A	Paper Citation	Authors	Year of Publication	OHSMS Standard	Type of Paper Data or Material	Field of Application	Source
(A)	(B)	(C)	(D)	(E)	(F)	(G)	(H)
1	[53]	Jørgensen T.H. Arne Remmen M. Dolores Mellado	2006	ISO 14001; OHSAS 18001	Empirical/Qualitative	All Sectors	JCP
2	[54]	J.R. Santos-Reyes and & Beard, A. N.	2006	BS8800	Empirical/Qualitative	All Sectors	JPS
3	[55]	Adele Abrahms	2006	ANZI Z10-2005	Empirical/Qualitative	All Sectors	JPS
4	[56]	Manuele, Fred	2006	ANZI Z10-2005	Empirical/Qualitative	All Sectors	JPS
5	[57]	Wrona	2006	ANSI Z16.2	Empirical/Qualitative	All Sectors	JSR
6	[58]	Nielsen et al.	2006	OHSAS 18001	Empirical/Qualitative	Industrial sector	JSR
7	[59]	Cadieux et al.	2006	OHSAS 18001	Empirical/Qualitative	Industrial sector	JSR
8	[60]	Paivinen	2006	BS 8800	Empirical/Qualitative	Telecommunications	IJIE
9	[61]	S.X. Zeng, Jonathan J., Shi G.X. Lou	2007	OHSAS 18001	Questionnaires	All Sectors	JCP
10	[62]	Fernandez-Muniz et al.	2007	BS 8800, OHSAS 18001	Empirical/Qualitative	Industrial sector	JLPII
11	[63]	Coleman and Kerkering	2007	ANSI Z16.1-1967	Accidents Data	Mining	JSR
12	[3]	Robson et al.	2007	ANSI Z10, OHSAS 18001, BS8800, HSG 65	Quantitative	All Sectors	JSS
13	[64]	Bevilacqua et al.	2008	OHSAS 18001	Quantitative	Oil & Refinery	AAP
14	[65]	Brooks	2008	ANSI Z10	Quantitative	All Sectors	JSS
15	[66]	Duijm et al.	2008	BS 8800, OHSAS 18000, ILO-OSH 2001, HSG 65	Questionnaires	Industrial sector	JSS
16	[67]	Lind, Kivisto-Rahnasto	2008	BS 8800, ILO-OSH:2001, OHSAS 18001	Case Study	Transportations Sector	JSS
17	[68]	Nielsen et al.	2008	OHSAS 18001	Quantitative	Industrial sector	JSS
18	[69]	Schrover	2008	ISO-9001, ISO-14001, OHSAS-18001	Theoretical Foundations	Chemical Sector	JSS
19	[70]	Zeng et al.	2008	OHSAS 18001, ISO 9001	Accidents Data	Construction Sector	JSS
20	[71]	Komljenovic et al.	2008	AS/NZS: 1999, CAN/CSA Q850-97: 2002. ISO, 1999, 2000, ANSI: 2000, ASTM E2205-02, 2002	Accidents Data	Mining	JSS
21	[72]	Caroly et al.	2009	OHSAS 18001	Empirical/Qualitative	Chemical Sector	JAIE
22	[73]	Chang and Liang,	2009	OHSAS 18001, ILO-OSH-2001, BS 8800, HSG 65	Empirical/Qualitative	Chemical Sector	JLPII
23	[74]	Santos-Reyes, Beard	2009	BS 8800, ILO-OSH: 2001, HSG 65	Empirical/Qualitative	Oil & Refinery	JLPII
24	[75]	Crippa et al.	2009	OHSAS 18001	Quantitative	Oil & Refinery	JLPII
25	[76]	Knegtering, Pasman,	2009	OHSAS 18001	Empirical/Qualitative	Industrial sector	JLPII
26	[77]	Pasman et al.	2009	OHSAS 18001	Empirical/Qualitative	Industrial sector	JLPII
27	[78]	Moriyama, Ohtani	2009	ILO-OSH 2001, BS 8800	Empirical/Qualitative	Food Sector	JSS
28	[79]	Fernandez-Muniz et al.	2009	BS 8800, OHSAS 18001	Questionnaires	All Sectors	JSS
29	[80]	Celik M.	2009	OHSAS 18001:2007	Quantitative	Shipbuilding Sector	JSS
30	[81]	Reniers et al.	2009	OHSAS 18000	Empirical/Qualitative	All Sectors	JSS
31	[82]	Baram	2009	ILO-OSH 2001	Empirical/Qualitative	Industrial sector	JSS
32	[83]	Shengli Niu,	2010	ILO-OSH 2001	Empirical/Qualitative	All Sectors	JAIE
33	[84]	Gangolells et al.	2010	OHSAS 18001	Quantitative	Construction Sector	JSR
34	[85]	Cheng et al.	2010	ANSI Z10	Quantitative	Construction Sector	JSS
35	[86]	Jacinto, Silva	2010	BS 8800	Case Study	Shipbuilding Sector	JSS
36	[87]	Sgourou et al.	2010	BS 8800	Quantitative	All Sectors	JSS

Table A1. Cont.

A/A	Paper Citation	Authors	Year of Publication	OHSMS Standard	Type of Paper Data or Material	Field of Application	Source
(A)	(B)	(C)	(D)	(E)	(F)	(G)	(H)
37	[88]	Fera, Macchiaroli	2010	OSHAS 18001	Case Study	All Sectors	JSS
38	[89]	Lindhout et al.	2010	OHSAS 18001	Empirical/Qualitative	Chemical Sector	JSS
39	[90]	Celik M.	2010	ISO 9001:2000, ISO 14001:2004, OHSAS 18001:2007	Case Study	Shipbuilding sector	JSS
40	[91]	Dawson et al.	2011	AS/NZ 4360	Empirical/Qualitative	All Sectors	AAP
41	[92]	Low Sui Phen & Goh Kim Kwang	2011	ISO 14001; OHSAS 18001	Questionnaires	Construction Sector	ASR
42	[93]	Jallon et al.	2011	OHSAS 18001	Quantitative	Industrial sector	JSR
43	[94]	Leka et al.	2011	ILO-OSH 2001, BS OHSAS and ANSI Z-10	Empirical/Qualitative	Construction Sector	JSS
44	[95]	Blewett, O'Keeffe	2011	ANSI Z10, OHSAS 18001	Quantitative	Food Sector	JSS
45	[96]	Vinodkumar, Bhasi	2011	OHSAS 18001, BS 8800	Questionnaires	Chemical Sector	JSS
46	[97]	Hohnen, Hasle	2011	OHSAS 18001	Case Study	All Sectors	JSS
47	[98]	Lu, Li	2011	OHSAS 18001	Case Study	Mining	JSS
48	[99]	Zwetsloot et al.	2011	OHSAS 18001	Case Study	Industrial sector	JSS
49	[100]	Frick	2011	ANSI Z-10, (2005), Australia and New Zealand (AS/NZS 4804), The Netherlands (NPR 5001), Spain (UNE 81900), UK (BS 8800), ISO 9000, ISO 14000, OHSAS:18001, ILO-OSH 2001	Theoretical Foundations	Industrial sector	JSS
50	[101]	Granerud, Rocha	2011	OHSAS 18001, ISO 14000, ISO 9000	Case Study	Industrial sector	JSS
51	[102]	Kristensen	2011	ISO 14001, OHSAS 18001	Case Study	Industrial sector	JSS
52	[103]	Zwetsloot et al.	2011	ISO 9000, ISO 14000, OHSAS 18000 series	Case Study	Industrial sector	JSS
53	[104]	Hasle Peter, Gerard Zwetsloot	2011	OHSAS 18001	Quantitative, Empirical/Qualitative	Industrial Sector	JSS
54	[105]	Beatriz Fernández-Muñiz, José Manuel Montes-Peón,, Camilo José Vázquez-Ordás	2012	OHSAS 18001	Empirical/Qualitative	All Sectors	AAP
55	[106]	Goh, Y.M. et al.	2012	AS/NZS 4801	Empirical/Qualitative	Construction Sector	AAP
56	[107]	Cheng et al.	2012	ANSI Z.16.2-1995, ILO Guidelines	Quantitative	Construction Sector	AAP
57	[108]	Pinto et al.	2012	BS 8800:2004	Quantitative	Construction Sector	AAP
58	[109]	Badri et al.	2012	OHSAS 18000	Case Study	Industrial sector	AAP
59	[110]	Luria Gil, Ido Morag	2012	OHSAS 18001	Empirical/Qualitative	All Sectors	AAP
60	[111]	Beatriz Fernández Muñiz José Manuel Montes-Peón Camilo José Vázquez-Ordás	2012	OHSAS 18001	Questionnaires	All Sectors	JCP
61	[112]	Jeremy Mawhood & Claire Dickinson	2012	HSG 65	Empirical/Qualitative	Railways Sector	JPS
62	[113]	Lee et al.	2012	BS 8800, OHSAS 18001, ILO-OSH 2001	Accidents data	All Sectors	JLPII
63	[114]	Gnoni, Lettera	2012	OHSAS 18001	Empirical/Qualitative	Industrial sector	JLPII
64	[115]	Badri et al.	2012	ANSI Z10	Empirical/Qualitative	Industrial sector	JSS
65	[116]	Hamidi et al.	2012	OHSAS-18001, ANSI z10	Case Study	Construction Sector	JSS
66	[117]	Hsu et al.	2012	OHSAS: 18001, BS 8800,ILOOSH 2001	Quantitative	Food Sector	JSS
67	[118]	Wang, Liu	2012	OHSAS 18001, ILO-OSH 2001, HSG 65	Questionnaires	Railways Sector	JSS
68	[119]	Ismail et al.	2012	OHSAS 18001	Empirical/Qualitative	Construction Sector	JSS
69	[120]	Jesús Abad, Esteban Lafuente, Jordi Vilajosana	2013	OHSAS 18001	Accidents data	All Sectors	JSS
70	[121]	Santos G. et al.	2013	OHSAS 18001	Questionnaires	Industrial Sector	JSS

Table A1. Cont.

A/A	Paper Citation	Authors	Year of Publication	OHSMS Standard	Type of Paper Data or Material	Field of Application	Source
(A)	(B)	(C)	(D)	(E)	(F)	(G)	(H)
71	[122]	Chris K.Y. Lo, Mark Pagell, Di Fan, Frank Wiengarten, Andy C.L. Yeung	2014	OHSAS 18001	Case Study	Construction Sector	JOM
72	[123]	Yazdani A. et al.	2015	OHSAS18001, BS 8800:2004	Empirical/Qualitative	Industrial Sector	JAE
73	[51]	Autenrieth D.A. et al.	2016	OHSAS 18001, ANZI 10	Case Study	Industrial Sector	JSS
74	[124]	Miskeen Ali Gopang, et al.	2017	ILO-OSH 2001	Empirical/Qualitative	Other Sectors	JSS
75	[125]	Segarra Cañamares M. et al.	2017	OHSAS 18001	Case Study	Construction Sector	JSS

Appendix B

Table A2 presents statistical results of ten (10) journals investigation, concerning articles with OHSMS standards (during 2006–2017).

Table A2. Statistical results of ten (10) journals investigation, concerning articles with OHSMS.

Nr	Journal	Acronym	Number of Investigated Papers (Absolute Frequency Ni)	Relative Frequency (Fi = Ni/N) (%)	Number of Papers Concerning OHS Which Include or Use OHSMS Standards (n _{ST(i)})	Relative Occurrence Frequency of Papers (Referred to N) Which Include OHSMS-Standards (f _i _{ST(i)} = n _{ST(i)} /N) (%)	Normalized (Per Journal) Occurrence Frequency of Papers Which Include OHSMS Standards (f _i [*] = n _{ST(i)} /N _i) (%)	Relative Occurrence Frequency of Papers (Referred to S) Which Include OHSMS Standards (f _{ST(i)} [*] = n _{ST(i)} /S) (%)
	(A)	(B)	(C)	(D) = (C)/N	(E)	(F) = (E)/N	(G) = (E)/(C)	(H) = (E)/S
1	Applied Ergonomics	JAE	886	9.02%	3	0.03%	0.34%	4.00%
2	Accident Analysis and Prevention	AAP	1522	15.50%	8	0.08%	0.53%	10.67%
3	Journal of Cleaner Production	JCP	1005	10.23%	3	0.03%	0.30%	4.00%
4	Journal of Operations Management	JOM	995	10.13%	1	0.01%	0.10%	1.33%
5	Architectural Science Review	ASR	1007	10.25%	1	0.01%	0.10%	1.33%
6	Safety Science	JSS	945	9.62%	40	0.41%	4.23%	53.33%
7	Professional Safety	JPS	998	10.16%	4	0.04%	0.40%	5.33%
8	Journal of Loss Prevention in the Process Industries	JLPPI	881	8.97%	8	0.08%	0.91%	10.67%
9	International Journal of Industrial Ergonomics	IJIE	955	9.72%	1	0.01%	0.10%	1.33%
10	Journal of Safety Research	JSR	628	6.39%	6	0.06%	0.96%	8.00%
Totals:			9822	100.00%	75	0.76%	7.96%	100.00%

Annotations: The entire (total) absolute frequency (i.e., the total number of investigated articles) is: N = 9822; The number of articles that concern OHSS and include (or use or refer to) OHSMS standards is: S = 75.

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