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An Inquiry into the Health and Safety Management Practices of Construction Firms in South Korea

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Abstract

Purpose- This research aims to investigate the Occupational Safety and Health (OSH) management practices of construction companies in South Korea to ascertain specific components and practices that need improvement for successful OSH performance.
Design/methodology/approach- A quantitative research strategy was adopted. A close-ended questionnaire survey covering 45 OSH management practices was sent to 324 contractors; 108 responses were gathered, representing a response rate of 33.3%. Data were analyzed using simple descriptive statistics (frequencies and percentages) and Pearson's chi-square test.
Findings- The findings revealed that there is a moderate level of implementation of OSH management practices among construction firms in South Korea. However, there is a significant disparity in terms of implementation between large enterprises on the one hand and small to medium enterprises (SMEs) on the other. Furthermore, a few of the business characteristics (i.e., the size of companies and certification to OHSAS 18001) were closely associated with the extent of the implementation of OSH management practices.
Practical implications- This research uncovers the OSH management practices that are poorly implemented and lays the foundation for appropriate measures to improve OSH in South Korean construction companies. It suggests an effective strategy for communicating health and safety issues to workers, training safety managers, reviewing risk assessments, reviewing the health and safety plan, incentivizing workers by rewarding good behaviour, and having a penal mechanism for employees not adhering to the rules.
Originality/value- The study provides insights into an under-investigated South Korean construction industry topic. It offers additional insight into state-of-the-art health and safety management practices in the construction industry in South Korea. Furthermore, it establishes which components of OSH management practice require improvement in the Korean Context. This is also one of the few studies in OSH which establishes the association between the construction business characteristics and OSH management in the South Korean construction domain.

Keywords: Construction firms; construction industry; occupational safety and health management; South Korea

1. Introduction

Although there is no agreed consensus on the value of the global construction market, a study by Oxford Economics estimated its value to be about US$ 10.7 trillion in 2020 (Oxford Economics, 2021). It is expected to grow by US$ 4.5 trillion between 2020 and 2030 to reach US$ 15.2 trillion, with US$ 8.9 trillion of that share occurring in emerging markets in 2030 (Oxford Economics, 2021). In addition to being a major contributor to the economy of most countries, the construction industry is also a significant employer (Agyekum et al., 2022). For example, on average, about 10% of employees in the UK are engaged in the construction industry (Haynes, 2017). In the United States of America (USA), construction workers account for 4.3% of the labour force (Bureau of Labour Statistics, 2017). Similarly, the construction industry in South Korea contributes 4.7% of the GDP (Korea Employment Information Service, 2016) and employs 7.5% of the working population (Ministry of Employment and Labour, Korea, 2015).

Despite its significant contributions to global GDP, the construction industry performs poorly regarding health and safety (Agyekum et al., 2021). For instance, in the United Kingdom (UK), the construction sector recorded the highest number of fatalities in 2020/21 (Health and Safety Executive (HSE), 2021). Similarly, the sector accounted for the highest fatalities in the USA in 2020 (Bureau of Labour Statistics, 2021) and the European Union in 2019 (Eurostat, 2022). Globally, the construction sector is estimated to account for over 100,000 fatalities annually (International Labour Organisation (ILO) (2015). South Korea is no different in this regard. However, while South Korea is a high-income country and thus expected to have a fatality rate similar to other high-income countries such as the United Kingdom and America, the country's construction industry occupational fatality rate is over 20 times that of other developed countries such as the UK (Ministry of Employment and Labour (MOEL), Korea, 2015; HSE, 2021; World Bank, 2022). The construction industry accounts for 26.3% of all fatalities in the country (Ministry of Employment and Labour, Korea, 2015). Even though the World Bank in 2021 ranked South Korea 10th in the gross domestic product (GDP) and the ninth greatest trading nation in the world, its occupational fatality rate is poor (https://databankfiles.worldbank.org/public/ddpext_download/GDP.pdf). For instance, in 2021, around 2,080 workers in South Korea died in work-related accidents, marking an increase of deaths from the previous year that stood at 2,062 (Yoon, 2023). Currently, South Korea still remains one of the countries with a comparatively high work-related fatality rate globally (Yoon, 2023). Invariably, the high rate of fatalities in the South Korea construction industry is worrying, as it has operational, personal, social, and financial implications (Eurostat, 2022).

Concomitantly, the Institution of Occupational Safety and Health (IOSH) has indicated that Occupational Safety and Health Management Systems (OSHMS) could prevent workers from accident risks and hazards through well-organized planning, monitoring, control, and prediction (IOSH, 2015). Literature on OSHMS reveals that its proper implementation could decrease illnesses and injuries in organizations by up to 24% (Lakhiar and Lakhiar, 2021; Robson et al., 2007). Furthermore, empirical analysis by Arocena and Nunez (2010) has indicated that OHSMSs considerably influence accident rates.

South Korea is familiar with the concept of OSH. The Korea Occupational Safety and Health Agency (KOSHA) was established in 1987 (Yoon, 2013). Its establishment led to the opening of training institutes, research institutes, and several local offices. KOSHA developed KOSHA 2000 in 1999 and K-OHSMS 18001 in 2001, which were trialled by numerous companies. Whereas 876 companies across industries had pursued the qualification as of late 2011, only 17 of about 1,000 construction companies were certified. No small and medium enterprises (SMEs) were certificated, although SMEs employ about 70% of construction workers – the majority of the workforce in South Korea (Yoon, 2013). There is minimal understanding of why many of these SMEs are not pursuing such certification thus necessitating the need for additional; research and insight into why these SMEs are reluctant to obtain the relevant certification.

Some of the existing research regarding the health and safety of construction companies in South Korea has instead focussed on the status analysis of occupational accidents and analysing trends in construction industry accidents (Kim et al., 2017). More attention should instead be

directed to the drivers for adopting OSH, barriers to adopting OSH, and the actual OSH management practices of construction companies in Korea. Given the high fatality rate in the South Korean construction industry, such insights are essential as they lead to understanding the effectiveness of such OSH management practices in preventing accidents. They also lead to an understanding of why SMEs are not adopting OSH management practices as required. Therefore, this study investigates the level of implementation of health and safety management practices within construction firms in South Korea. The findings from this study help to ascertain specific components and practices that need to be improved for successful OSH performance in the construction industry in South Korea.

The paper is divided into five sections. The first section introduces readers to the theme under investigation. Under this section, a brief background is provided. Next, the problem is stated and discussed. Finally, the research gaps are identified, and the aim and specific objectives are stated. The second section of the paper is the literature review. This section reviews the literature on key concepts of OSH and its implementation in the construction industry. The third section describes the methodology adopted for this study. The fourth section presents and discusses the results, and the final section concludes the study.

2. Literature review

This section reviews literature pertinent to the theme under investigation. It is divided into three sub-sections and starts off by providing an overview of construction health and safety in South Korea. A review of the main OSH Management systems is undertaken, following which empirical studies relating to health and safety are evaluated. These will be discussed in seriatim:

2.1 Overview of Construction Health and Safety in South Korea

South Korea experienced rapid industrialisation in the 1970s. This rapid industrialization in turn boosted industrial accidents and social awareness of occupational safety and health (OSH) in the 1970s (Musarat et al., 2022; and Lim, 2012). In 1981, the Occupational Safety and Health Act (OSHA) of Korea was established. This was followed by the Korea Occupational Safety and Health Agency (KOSHA) in 1987. Subsequently, several medium and long-term policies have been formulated and implemented over the last three decades in an attempt to improve occupational health and safety records. These include the first 6-year-plan for industrial accident prevention (1991), the 3-year-plan for occupational safety advancement (1997), and the first–third 5-year-plan for industrial accident prevention (2000–2010 Germany) (Lim, 2012). Occupational health especially took root in 1991 with comprehensive measures for occupational disease prevention.

Despite several medium and long-term policies, the OSHA is the basic legislation for OSH in South Korea. Additional to these, the Enforcement Decree of the OSHA and the Ordinance of the OSH Standards are two other regulations held in high esteem in Korea (ILO, 2015). The former contains specific safety and health standards regulations, while the latter deals with more generic issues (ILO, 2015). The Occupational Safety and Health Act aims to maintain and promote the safety and health of workers by preventing industrial accidents and creating

comfortable working environments by establishing standards on occupational safety and health and clarifying where the responsibilities lie (MOEL, 2012). Specifically, the Act emphasizes the assignment of several managers to play a vital role in health and safety on site. For example, the safety manager is responsible for the overall management and control of many kinds of matters, such as accident and disease prevention plans, and employees' education among others.

Oh et al. (2021) assert that construction health and safety in South Korea is divided into two management categories, i.e., facilities and workers. Each of these two categories is regulated by a unique government agency, depending on the subject of the accident. Safety issues related to facilities are dealt with by the Ministry of Land, Infrastructure, and Transport (Oh et al., 2021). That of workers and their actions are handled by the Ministry of Employment and Labour in South Korea (Oh et al., 2021). This suggests that two organizations are involved in regulating and managing construction safety, albeit with differing perspectives.

Notwithstanding the presence of the OSH Act and the regulatory oversight provided by the two government agencies, safety performance remains a challenge, as Korea's overall construction industry mortality rate increased from about 4% in 2009 to around 10% by 2019 (Korea Occupational Safety and Health Agency, 2019). This rate is high when compared to other developed countries such as Germany (rate of 4.0 per every 100, 000 workers), the United Kingdom (rate of 1.9 per every 100,000 workers), and Australia (rate of 2.2 per every 100,000 workers) (Centre for Construction Research and Training, 2018). Therefore, it raises the question of why South Korea experiences a much higher health and safety accident rate than other high-income countries.

2.2 Review of OSH Management Systems

Occupational safety and health management systems (OSHMSs) have been relied on as a critical management strategy for OHS since the 1990s (Simukonda et al., 2020). Lingard and Rowlinson (2005) posited that the solutions capable of improving OSH had earlier relied on strategies for keeping the physical environment safe. Nevertheless, as the nature of operations of various industries became dynamic, new approaches to sustaining OSH became necessary (Simukonda et al., 2020). In view of this, there have been calls to establish an integrated management system (ISM) to manage OSH. This is because there are financial constraints and operational challenges to operating separate management systems (Ahn et al., 2022; Jørgensen et al., 2006). The idea of this integration has caused some organizations to amalgamate several aspects of (separate) quality, environmental, and OSH management systems (Zutshi and Sohal, 2005). Notwithstanding the need to incorporate the IMS in organizations, there are still separate management systems in use. A typical example is Standard No. OHSAS 18001:2007 (British Standard Institution, 2007) for OSH management. More broadly, these OSHMS or models include but are not limited to the following: ILO-OSH 2001; Australia and New Zealand (Au/NZS) 4801: 2001, Canadian Standards Association (CSA) Z1000: 2006, BS OSAS 18001: 2007 (BSI 2007), American National Standard for OHSMS (AN SI Z10: 2012), and Managing for Health and Safety Guide (HSG) 65 (HSE, 2013).

The ILO-OSH 2001 guideline aims to prevent workers from being exposed to dangerous situations and risks and improve productivity (ILO, 2009). The guideline presents practical

approaches to assist organizations in establishing, implementing, and enhancing OHSMSs at national and organizational levels. It consists of five components, i.e., Policy, Organizing, Planning and Implementation, Evaluation, and Action for Improvement (ILO, 2009). At the national level, the guideline fosters the establishment of national laws and regulations that advance occupational safety and health performance. The organizational level encourages the integration of OSHMS elements while motivating organizations to apply proper occupational safety and health management principles and methods.

The Australia and New Zealand (Au/NZS) 4801: 2001 is a specification standard that plays a role in independent external audits and is also a framework for internal audits. It aims to achieve optimal OSH performance levels with systematic risk management. This joint standard seeks to replace and amalgamate the previous versions of both AS4801:2000 and NZS 4801:1999, sharing common management system principles with International Organization for Standardization (ISO) 14001(2000) environmental system and ISO 9001 (2015) quality system. It consists of five key components, i.e., OHS Policy, Planning, Implementation, Measurement and Evaluation, and Management Review. All these components seek to ensure the continual improvement of OSH.

The CSA Z1000: 2006 standard was first published regarding OHSMS in Canada and harmonized well with ANSI Z10 but did not require rigorous certification. The system is based on quality-management principles by Deming (Floyd, 2011). It does operate on the Plan, Do, Check, and Act principle. In addition, the standard includes fundamental performance requirements – such as management commitment and leadership, worker participation, planning, Implementation, evaluation, corrective action, and management review.

The BS OSHAS 18001: 2007 (BSI 2007) is a second edition model that focuses on clarifying and superseding the first edition (OSHAS 18001:1999) and has been advanced through compatibility with the ISO 9001:2000 and ISO 14001:2000, representing quality and the environment, respectively. It optimizes the integration of quality, environmental and occupational OSH management systems. The main changes consist of several elements, such as emphasizing health as the basis for the national standard, the 'Plan-Do-Check-Act' model diagram, and improved compatibility with ISO 14001 and ISO 9001. Specifically, this standard is also based on the well-known Plan-Do-Check-Act (PDCA) principle.

The American National Standard for OHSMS (AN SI Z10: 2012) is a programme based on the Deming Cycle for continual improvement and a case similar to the PDCA process, which the ISO 14001 Standard utilizes for Environmental Management Systems (Toy 2019; Manuele, 2014). Additionally, the AN SI Z10 cycle has five fundamental elements, i.e., Management Leadership and Employee Participation, Planning, Evaluation and Corrective Action, Implementation and Operation, and Management Review. Z10 emphasizes management leadership and employee participation, which aims to involve all employees and workers and impose responsibilities on all managers and safety managers trained in safety and health. Moreover, it tries to apply to every industry and focuses on every organization (Toy, 2019; Toy and Dotson, 2013).

Managing for OSH, HSG 65 (HSE, 2013) is a third edition model and the most popular and helpful guide for leaders, owners, and managers who must set out the arrangements and supervise their organization’s OSH performance, workers, and professionals. The guidance

emphasizes integral management and advises on four main factors: core elements of managing, requisition for making a decision, delivering effective arrangement, and essential resources from other organizations with the Plan-Do-Check-Act approach. Moreover, sixteen (16) critical actions needed to be effective in each part are provided for the involvement and competency of leaders, managers, and workers.

Some key elements are systematically extracted from the critical literature review regarding the health and safety management systems above (see Table 1). These components formed the basis of the questionnaire development.

[INSERT TABLE 1]

2.3 Empirical Review of Related Studies

The prior sections of this paper have broadly reviewed the concepts of OSH and OSHMS in South Korea. However, given the paper's focus on construction companies' occupational safety and health (OSH) management practices, it is appropriate to undertake a critical comparative review of the related literature in the construction sector. Therefore, a micro-scoping was adopted for the review (Ambekar et al., 2022). The micro-scoping strategy was preferred because this is not a review paper; hence, it would not have been appropriate to go with the Preferred Reporting Items for Systematic Reviews, and Meta-Analyses (PRISMA) associated with the systematic literature review. Therefore, the review was restricted only to published studies in the English Language that was empirical. These studies were identified through a keyword search. The keywords used include; Construction Firms, Construction industry, Occupational Safety and Health Management, and Health and Safety in the Construction Industry, among others. The search was performed in significant literature databases and engines like Emerald, Taylor and Francis, Scopus, and Web of Science. Empirical papers that focus on health and safety in the construction industry are subsequently selected and reviewed.

Previous studies have explored the role of OSH management practices in the performance of OSH in various organizations. For example, Simukonda et al. (2020) investigated OSH management by construction companies in Malawi. They revealed the low implementation of OSH management practices, especially those related to policy, organizing, measuring, reviewing, and auditing. The study also indicated that company size influenced the implementation of such practices despite the low level of implementation. In a related study, Smallwood (2017) argued that OSH performance is significantly positively influenced and can be improved by well-organized OSH systems, such as structured programmes, consultant guidance and inspection and focus, and client awareness. In earlier research by Smallwood (2015), it was revealed that stakeholders with the most critical role in OSH management were OSH coordinators and OSH managers.

In Spain, a study by Abad et al. (2013) revealed that although safety culture is deeply embedded in construction firms, there are still cases of safety issues among such firms. Notwithstanding, these cases decreased with time, and this improved productivity on Spanish construction sites (Abad et al., 2013). Robson et al. (2007) conducted a systematic literature review of thirteen (13) articles on the effectiveness of OSHMSs in addressing occupational accidents. The findings revealed that accident frequency decreased by 24–34 and 18% for voluntary and

mandatory OSHMSs. In addition, a 13–52% decrease in workers' compensation was recorded over three years (Robson et al., 2007). These studies and others demonstrate the effectiveness of OSHMSs in addressing OSH management performance challenges.

In the Republic of South Korea, one of the key studies on OSH management is that of Yoon et al. (2013). In their study, the effect of OSHMSs on work-related accident rates in the construction industry was explored. Their findings revealed an average accident rate of 0.18 and 0.30 victims per every one hundred employees who work in both certified and non-certified construction firms annually. Aside from the study of Yoon et al. (2013), many other studies focusing on health and safety in Korean construction do not provide insights into the extent of implementation of OSH management practices among contractors operating in the industry. Furthermore, there is a lack of understanding regarding the associations between other company characteristics and the implementation of OSH management practices.

3. Methodology

This study investigates the implementation of health and safety management practices within construction firms in South Korea. A quantitative research design using a survey instrument was adopted to achieve this aim. The quantitative survey approach was used due to its suitability for obtaining a generalized view of a phenomenon (Pittri et al., 2023; Simukonda et al., 2020), which in the case of this study is the OSH management practices of construction companies in South Korea and the level of implementation of some key elements as per the OHSMS. Previous studies have also used the survey strategy to examine OSH management practices of construction companies in other countries (Simukonda et al., 2020; Kheni et al., 2008). In addition, the study targeted senior company management personnel, OSH managers, and engineers, as they are more likely to have good knowledge of their companies' OSH management strategies and practices.

3.1 Survey Design

A questionnaire instrument was designed for the survey after the review of pertinent literature on the subject matter. Variables were derived from existing literature on health and safety management practices and respondents were asked to tick which ones were appropriate. Using a two-step piloting procedure, the questionnaire's applicability for the expected feedback was confirmed before data collection. First, an expert in OSH management research conducted an initial questionnaire examination. Then, following his approval, three (3) senior company management personnel and three (3) OSH managers with experience in OSH management practices evaluated the feasibility of the crafted questions. After a few clarifications, both piloting phases were approved with minor revisions. These revisions were incorporated, and the final questionnaire was ready for data collection. The questionnaire comprised multiple questions with fixed response categories, i.e., dichotomous yes or no, multiple choices, and open-ended questions. The questionnaire comprised four sections as follows: (a) introduction (i.e., an introductory section containing general instructions for filling the questionnaire); (b) respondents' and company profile (i.e., professional role, size and age of firm, possession of certification and so on, which was used for the analysis of relationships between business characteristics and implementation of OSH management practices); and (c) business safety and health management practices. Section C required the respondents to tick from multiple-choice answers based on their organization's safety and health management practices. Questions such

as the organizations that their companies report accidents to and possession of designated health and safety management budget, amongst others, were asked. Drawing from practices within OSH management elements (i.e., summarized in Table 1), Section D elicited responses on the OSH management practices implemented by construction companies in South Korea. Respondents were asked to tick from their companies' OSH management practices. A total of 45 OSH management practices were probed.

The population for this study comprised construction companies in South Korea. For a more meaningful result, data was collected from large, small, and medium companies to compare how OSH management systems are being implemented. The prospective large companies' list was extracted from the 1st–50th ranks of Construction Ability Evaluation of Construction Firms in 2018 issued by the Construction Association of Korea (CAK) 2018. The SMEs were chosen from subcontractors, who usually work with large contractors in South Korea, including various business types such as electrical and mechanical, civil, finish, concrete, steelwork, etc. Although there seems to be a sample frame, this study had to use the purposive sampling approach. The purposive sampling approach helps to identify the cases, individuals, or communities best suited to answer a research question. This approach was deemed necessary because the researchers sought to obtain data from professionals with good knowledge of their companies' OSH management strategies and practices. Although this sampling approach is widely used in qualitative research for the identification and selection of information-rich cases related to a phenomenon of interest (Palinkas et al., 2015), it has also been well applied in construction safety management-related quantitative research (Sharar et al., 2022; Rantshilo et al., 2022). Through this sampling approach, 324 questionnaires were distributed among prospective respondents. Out of this number, 108 responses were gathered, representing a response rate of 33.3%. According to Delice (2010), causal-comparative, experimental studies and surveys within each minor sub-groups of a population require a sample size of at least 50. This conclusion was drawn based on an extensive review of previous studies as well as a review of minimum observation requirements for widely used multi-variant statistical techniques (Cohen et al., 2000; Delice, 2010; Field 2013). Based on this observation, the sample size of 108 in the present study is deemed adequate. Furthermore, previous studies in the field of construction management and safety have relied on comparable sample sizes for similar statistical analysis (Ankrah, 2007; Manu et al., 2018; Simukonda *et al.,* 2020).

A softcopy of the questionnaire was emailed to the selected companies using the Bristol Online Survey (BOS) link, which participants could directly access. This eliminated the effort required to reply to an email. The target respondents were site managers/engineers, OSH managers/supervisors, or head office managers with more than five years' experience because they were likely to have a high understanding and good knowledge of their companies' OSH management practices.

3.2 Data Analyses

The data were screened and coded to obtain numerical values for analysis. Subsequently, the data were exported to SPSS version 23.0. The level of implementation of OSH management practices by the construction companies was assessed based on Simukonda et al.'s (2020) categorization of the implementation levels, i.e., low implementation (i.e., where 0–49% of companies implement a practice), moderate implementation (i.e., where 50–59% of companies implement a practice) and high implementation (i.e., where over 70% of companies implement

a practice). The procedure adopted for establishing the associations between business characteristics and implementing OSH management practices involved using Pearson's $\chi 2$ test as employed by Kheni et al. (2008) and Simukonda et al. (2020). Three hypotheses were formulated and tested. The hypotheses are as follows:

- H_1: company age will be significantly associated with the implementation of OSH management practices;
- H_2: Certification to Standard No. OHSAS 18001: 2007 will be significantly associated with the implementation of OSH management practices; and
- H_3: Company size will be significantly associated with implementing OSH management practices.

4. Findings

The study results are presented under three sections: respondents' and company profiles, OSH management practices, and the relationship between the business characteristics and implementation of OSH management practices.

4.1 Respondents' and company profile

The total response rate was precisely one-third (33.3%), which is much higher than the research surveys conducted in Cambodia (14%), Vietnam (24%), and Malaysia (7%) (Manu et al., 2018). The primary role of respondents who participated in the survey consists of head office director/manager or OSH manager/supervisor, accounting for around 70% of respondents in both groups of large and small–medium companies.

More than 70% of respondents have worked in the construction industry for more than ten years; thus, they can be regarded as experienced with a broad understanding and know-how in the construction industry. Respondents with more than 15 years of experience, on the other hand, make up about one-third and one-quarter of the two groups, respectively. Thus, the participants' responses can represent companies' OSH practices in the study context.

The companies' profiles are presented in Table 2 in four categories: number of employees, age of establishment, categories of registration, and annual revenue. The number of employees is checked to ensure the companies' size, and the companies with more than 200 employees are defined as large companies. Most companies have been established for ten years and operate as construction firms. For categories of companies' registration, most companies are undertaking construction in multiple sectors such as public, private works and general building, and civil works. Large companies show this tendency more than SMEs. As far as companies' annual revenue in 2017 is concerned, most large companies present over £300 million, while about 70% of small–medium companies present less than £30 million, demonstrating that company size is related to the number of employees and annual turnover.

[INSERT TABLE 2]

4.2 Businesses' OSH Management Characteristics

Under the businesses' OSH management characteristics, the possession status of certification of KOSHA 18001 and BS OSHAS 18001 or ISO 45001 of the two business groups were the most sought after. All the large companies possessed KOSHA 18001 certification (Korean standard for OSH management), and 72.5% possessed BS OHSAS 18001 (international standard for OSH management). About a quarter of the small–medium companies possess KOSHA 18001 certification, and about a fifth possess BS OHSAS 18001.

4.3 Level of Implementation of OSH Management Practices

Table 3 presents results for the statistical analysis of the implementation of OSH management practices. Again, the practices were dichotomous, yes or no, and were defined as follows: 1 = *yes* (i.e., Implementation of OSH management practice) and 0 = *no* (i.e., Non-implementation of OSH management practice). To show the OSH management practices implemented across construction firms, attention is drawn to the percentage of companies implementing a practice. As highlighted earlier, the levels of implementation are categorized into low implementation (i.e., 0–49%), moderate implementation (i.e., 50–69%), and high implementation (i.e., over 70%) (Simukonda et al. 2018).

From Table 3, it is evident that as far as the results of large companies are concerned, almost all 45 elements (93.3%) are evaluated as high degree (i.e., over 70%). The only one that has a weak point is "*Assigning and providing OSH supervisors and directors*." This is mainly because OSH managers usually perform the role of OSH supervisor simultaneously in South Korean construction sites. Also, the two roles are separate in the Korean Industrial Safety and Health Act, which only stipulates how many OSH managers must be allocated to the sites according to the type and size.

[INSERT TABLE 3]

On the other hand, SMEs show several low-level practices – 28, accounting for 62% (28/45). To be specific:

- *Policy*: even though Pol 1 records high implementation, Pol 2 is low implementation, which is also not high for large companies.
- *Organizing*: is the worst part among the seven categories, presenting 84.6% (11/13) low-implementation percentage and including the lowest mark of Org 2 (13.2%) of all elements. Nevertheless, Org 3 and Org 4 show a moderate and high level, respectively.
- *Risk assessment***:** has the lowest implementation percentage at 40% (2/5), and there is one high-level practice, Risk 5.
- The low percentage of *Planning* is 60% (3/5), but no high-degree element exists. Risk 1 and Risk 3 experience moderate implementation.

- The category of *implementation* shows a similar percentage between moderate and low levels of 41.7% (5/12) and 50.0% (6/12), respectively. Impl 8 is the only high practice in this part, which shows the highest mark (91.2%) among all practices.
- *Measuring & Reviewing Performance*: there are three low, one moderate (Meas 4), and one high (Meas 5) practices.
- *Auditing*: has three elements, including two low practices and one high one (Aud 3). Aud 2 is one of the second-lowest practices (16.2%).

4.4 Association between Company Characteristics and OSH Management Practices

To identify significant statistical associations between company characteristics and OSH management practices, Pearson's chi-square test, which detects whether there is a relationship between two categorical variables, is used (Field, 2013; Curtis and Youngquist, 2013). Hess (2017) claims that Pearson's chi-square test and Fisher's exact test are used to verify the association among data categories in contingency tables. Moreover, although the accuracy of features makes Fisher's exact test generally preferable, Pearson's chi-square test is also helpful because it has computational and philosophic accessibility.

The statistical results are shown in Tables 6, 7, and 8. The three kinds of characteristics, including the age of the companies, business size, and BS OHSAS certification, are applied. The value of *p*, the typical statistical significance level, is applied at 0.05; thus, if the significance level is smaller than 0.05, the hypothesis that the variables are independent is rejected (Field, 2013). For brevity, statistically insignificant associations are not presented in the tables. Cramer's V is the figure that measures the strength of association considering sample size and degrees of freedom and tries to restrict the range of the test statistics to between 0 and 1.

4.4.1 Association between the Age of the Companies and the Implementation of OSH management practices:

Table 4 presents the results of the association between age and implementation of OSH practices. Fisher's exact test is applied to interpret the findings because this procedure is usually used on 2 x 2 contingency tables and small samples to overcome the problem that the chi-square test must have greater than five expected frequencies in each cell (Field, 2013). Even though the size of the contingency table for this characteristic is 2 x 3, Fisher's test is employed because one group of 3–10 years is almost meaningless because of the very small number of responses (0–2).

The finding shows that the age of the companies is significantly associated with only four practices **Pol 1***($X^2(df2) = 9.971$, $p=.008$)*, **Org 12***($X^2(df2) = 9.778$, $p=.008$)*, **Impl 2***($X^2(df2) = 7.250$, $p=.027$)* and **Impl 7***($X^2(df2) = 6.663$, $p=.036$)* without any association with the categories of Risk Assessment, Planning, Measuring and Auditing *(i.e., $p>.05$)*.

[INSERT TABLE 4]

4.4.2 Association between BS OHSAS certification and Implementation of OSH management practices:

In contrast to the first characteristic above, significant associations between BS OHSAS certification and implementation of OSH practices are presented with 35 practices (see the Supplementary Data 1 for the table that shows the association between BS OHSAS certification and the implementation of OSH management practices), 77.8% (35/45). Within this part, Fisher's test is only used for one component: Pol 1. Among all categories, Organisation shows the most significant association percentage at 92.3% (12/13), except for **Org 5***($X^2(df1) = 1.752$, $p=.186$)*, which is followed by the second group of Planning and Measuring & Reviewing Performance with 80.0% (4/5). On the other hand, Policy is the lowest part having 33.3% (1/3). Risk assessment, Auditing, and Implementation have a significant association percentage at 60% (3/5), 66.7% (2/3), and 75% (9/12), respectively. The practice having the biggest significant association is **Meas 2** *($X^2(df1) = 38.360$, $p=5.2^{-10}$)*, only one more than *30(=X^2)*. The result of association with KOSHA 18001 certification is omitted since the result is almost the same as the one for BS OHSAS 18001 certification.

4.4.3 Association between business size and Implementation of OSH management practices:

Business size is the characteristic that has the highest significant association with OSH management practices among the three characteristics of 40 components, 88.9% (40/45), as seen in the Supplementary Data 2. The likelihood ratio interprets the analysis of the findings because more than 20% of the expected counts are less than five (Field, 2013). Looking at each category, all Risk Assessment and Planning practices have a significant connection with companies' size. The five practices that do not have an association with this characteristic are as follows: **Pol 1***(Likelihood Ratio = 4.350, p=.500)*, **Pol 2***(Likelihood Ratio = 11.910, p=.064)*, **Org 2***(Likelihood Ratio = 6.990, p=.221)*, **Impl 8***(Likelihood Ratio = 7.983, p=.157)*, **Aud 3***(Likelihood Ratio = 8.520, p=.130)*.

5. Discussion

The results have established the status of OSH management practices of construction companies in South Korea, focused on ascertaining differences in implementation across organizational scales. This follows the approach adopted in similar studies conducted in other geographical contexts, including Nigeria, Cambodia, Vietnam, Malaysia, and Malawi (Manu et al., 2016; 2018; Simukonda et al., 2018). The overall level of Implementation of OSH management practices by South Korean construction companies is moderate, as seen in Table 3. According to Manu et al. (2018), this level is similar to Vietnam's and higher than Malaysia's and Cambodia's (see Table 5). Moreover, it is interesting to note that every category in South Korea experiences a similar tendency – i.e., the moderate level accounts for the most significant percentage by around half among all categories, except the category of Policy.

The Organising part shows a unique aspect, which has many low levels compared with the others. What makes matters worse is that two of its components have the lowest percentages

among all practices. This is mainly because most construction firms in South Korea tend not to classify safety managers and supervisors; instead, the safety managers simultaneously perform the supervisor's role on site. Additionally, Korean national health and safety legislation does not separate the roles either; in contrast, the UK clearly distinguishes between them and recommends allocating them separately in the sites (HSE 2013). Manu (2017) indicates that Malaysia, Vietnam, and Cambodia have a much higher frequency of this practice (Org 1) than South Korea (i.e., 22.2%) at 55.9%, 85.0%, and 63.2%, respectively. As for the OSH annual report, the companies often report accidents in their monthly and quarterly reports or whenever an accident happens and may not provide an annual report separately.

On the other hand, *Risk Assessment, Planning, Measuring, and Reviewing Performance* show a moderate place overall, except for just one practice each (Risk 4, Plan 3, and Meas 2). The British Standards Institutions (BSI, 2007) demonstrate that risk assessments help organizations identify occupational health and safety hazards, and risks must be considered for determining controls. Moreover, OSH risks and determining controls influence establishing, implementing, and maintaining OSH management systems.

Looking at practices that are over 80% (see Supplementary Data 2), regardless of the size of companies, Pol 1 comes in first among all components, showing the highest percentage at 90.7%. Most companies recognize the importance of OSH performance. They are well prepared for their own OSH policy statement, which is fundamental to OSH performance and signposts the direction organizations must take (BSI, 2007). The second highest practice is Impl 8 at 89.8%, reflecting that personal protective equipment, such as safety helmets, shoes, ankle bands, and belts, is well provided to workers. Risk 5 and Meas 5 take up the third rank with 87.0%. This may be because workers on South Korean construction sites must attend a morning stretching and light physical exercise meeting before starting work. Afterward, site managers share essential safety information with workers, and then each team performs toolbox talks to check all dangerous activities specifically. Lastly, Aud 3 is relatively high because head office managers in the OSH department occasionally visit sites to inspect and instruct OSH performance.

[INSERT TABLE 5]

Regarding the association between business characteristics and OSH management practices, the chi-square tests demonstrate that size and companies' certification of BS OHSAS 18001 are significantly associated with implementing 35 and 40 OSH practices (among the 45), respectively. In contrast, the age of companies is a significant association with the implementation of four practices. As a result, it is proved that SMEs and companies that still need to possess BS OHSAS 18001 certification may need a stronger point when implementing OSH management practices. This inference is supported by previous research, such as Awwad et al. (2015) and Yoon et al. (2013).

The research to date into OSH in the Korean construction industry has mainly focused on the effects and causes of accidents (e.g., Kim et al., 2017; Yoon et al., 2013). However, there is a

need to review how well OSH management practices are being performed in practice at workplaces because well-established OSH management systems enable organizations to decrease OSH risks and hazards systematically and to institute an effective management structure for the delivery of OSH objectives (BSI, 2007; HSE, 2013). Therefore, this research explores which OSH management practices are poorly implemented and, thus, which components need to be improved in South Korean construction companies. Furthermore, this study shows that there should be a special government policy or support for SMEs needing help to invest in high-quality OSH management. Lastly, the research indicates that the level of implementation of OSH management practices in the South Korean construction industry can generally be deemed to be moderate based on the responses of the study participants.

6. Practical Implications

Practically, this research uncovers the OSH management practices that are poorly implemented and lays the foundation for appropriate measures to improve OSH in South Korean construction companies. Furthermore, it establishes that for an improved health and safety record in the South Korean construction industry, there is a need for a focus on some essential factors such as: having an effective strategy for communicating health and safety-related issues to the workers, providing training to safety managers; reviewing and updating risk assessments during the construction phase; reviewing the health and safety plan during the construction phase; incentivizing workers by rewarding good behaviour; and having a penal mechanism for employees that do not adhere to the rules.

7. Theoretical Implications

This is one of the few studies in OSH which establishes the association between the construction business characteristics and OSH management in the construction domain. Theoretically, the study provides insights into an under-investigated South Korean construction industry topic. It offers additional insight into state-of-the-art health and safety management practices in the construction industry. The findings also contribute to the broader discourse on OSH management by suggesting that the association between business characteristics and OSH management may be more evident with certain elements, such as the organizing element.

8. Conclusion

This study investigated the health and safety (OSH) management practices of construction companies in South Korea to ascertain specific components and practices that need to be improved for successful OSH performance. After a critical review of the related literature, a questionnaire survey covering 45 OSH management practices containing closed-ended questions was developed and sent to collect data from 324 contractors in South Korea. The collected data from the survey respondents were analysed using simple descriptive statistics

(frequencies and percentages) and Pearson's chi-square test. The study's findings revealed overall that the implementation of OSH management practices by construction firms in South Korea is moderate. The results further showed a vast disparity in terms of implementation between large enterprises on the one hand and small to medium enterprises (SMEs) on the other. Furthermore, a few business characteristics (i.e., the size of companies and certification to OHSAS 18001) were closely associated with the extent of the implementation of OSH management practices. Inferences made from the findings assist in offering recommendations. These include:

- Implementing practical measures like the need to improve construction planning, unreasonable budget, and workers' insensitivity to OSH to improve OSH performance in the South Korean construction industry;
- The need to consider the role of OSH management practices in the construction industry in South Korea in enhancing OSH performance;
- The South Korean Government should support a special standard, regulation, or reward for SMEs to assist them in implementing OSH practices as quickly as possible; and
- Safety managers on construction sites need to be employed in permanent positions and to be free from excessive paperwork to concentrate on detecting risk activities and monitoring working conditions.

Even with the contribution made by this study, it has limitations. A key limitation of the study is its sole quantitative nature which did not allow the respondents to provide their verbatim comments regarding some of the issues. A qualitative approach could be used to explore barriers to implementing the OSH by these SMEs. Furthermore, the survey results could have been confirmed or substantiated through an alternative data collection technique like document analysis of OHS records; unfortunately, this still needs to be done. Future studies could therefore delve deeper into this study by considering these limitations.

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Table 1. Key elements and practices of OHSMSs

Area	Elements	Specific examples of practices	OSH Management Systems					
			ILO-OSH 2001	AS/NZS 4801:2001	CSA Z1000 :2006	BS OHSAS 18001:2007	ANSI Z10: 2012	HSE, 2013
Plan	**Policy**	Policy statement, overall responsibility	○	○	○	○	○	○
	Planning	Preparation, insurance, pricing, method statement, target	○	○	○	○	○	○
Do	**Risk Assessment**	Overall check, frequency, updating, notification, measure		○		○		○
	Organisation	Supervisor, communication, networking, training programme	○	○	○	○		○
	Implementation	Amendment, inspection, facilities, equipment, discipline	○	○	○	○	○	○
Check	**Measuring/ Review**	Record, investigating and publishing cause of accidents	○	○	○	○	○	○
Act	**Auditing**	Undertaking, external/internal organisation				○		○

Source: ILO (2009); Au/NZS (2001); BSI (2007); Enform (2011); ANSI Z10 (2012); HSE (2013)

Table 2. Profile of the companies

Companies' Profile	Large companies		Small–medium companies	
	Frequency	Percentage	Frequency	Percentage
Number of Employees				
Micro firm (Less than 10 employees)	-	0%	8	11.8%
Small firm (11–50 employees)	-	0%	31	45.6%
Medium firm (51–200 employees)	-	0%	29	42.6%
Large firm (Over 200 employees)	40	100%	-	0%
Age of Establishment				
Less than 3 years	-	0%	-	0%
3–10 years	-	0%	2	2.9%
10–20 years	5	12.5%	23	33.8%
Over 20 years	35	87.5%	42	61.8%

Category of Registration[a]				
Public sector works	28	70.0%	28	41.2%
Private sector works	29	72.5%	44	64.7%
General building works	36	90.0%	39	57.4%
General civil works	22	55.0%	13	19.1%
Mechanical & electrical works	16	40.0%	11	16.2%
Annual Revenue (GBP, 2017)				
0–7 million	-	0%	13	19.1%
7–30 million	1	2.5%	28	41.2%
30–70 million	-	0%	12	17.6%
70–130 million	2	5.0%	7	10.3%
130–300 million	2	5.0%	8	11.8%
Over 300 million	35	87.5%	-	0%

Note: [a] The sum of number and percentage is more than each total number and 100%, respectively, because many of the companies operate across several work categories.

Table 3. The extent of implementation of OSH management practices by construction firms in South Korea

H & S Management Elements & Practices	**Large Enterprises**			**SMEs**			**Total**
	Freq	%	Extent of Implementation	Freq	%	Extent of Implementation	%
Policy							

Po1	A formal company H&S policy statement	40	100.0	High	58	85.3	**High**	90.7
Po2	A company director with overall responsibility for H&S	20	50.0	Moderate	26	38.2	Low	42.6
Organizing								
Org1	A designated H&S department	34	85.0	High	14	20.6	Low	44.4
Org2	Providing H&S supervision on sites	15	37.5	Low	9	13.2	Low	22.2
Org3	A designated H&S manager	38	95.0	High	34	50.0	Moderate	66.7
Org4	Communicating H&S information to workers through newsletters, leaflets, posters etc.	38	95.0	High	47	69.1	**High**	78.7
Org5	Engaging with workers on H&S issues (e.g., H&S meetings and suggestion schemes)	30	75.0	High	28	41.2	Low	53.7
Org6	Networking with other institutions (e.g., insurance companies, government offices) about H&S issues	35	87.5	High	18	26.5	Low	49.1
Org7	Propagating H&S practices to external stakeholders (e.g., clients)	35	87.5	High	28	41.2	Low	58.3
Org8	Assessing the competence of workers & subcontractors	34	85.0	High	19	27.9	Low	49.1
Org9	Display of regulatory H&S posters on sites	38	95.0	High	26	38.2	Low	59.3
Org10	Open display of H&S policy on construction sites, company websites and head/branch offices	38	95.0	High	23	33.8	Low	56.5
Org11	Provision of H&S annual reports	31	77.5	High	11	16.2	Low	38.9
Org12	Provision of H&S training for site managers	37	92.5	High	25	36.8	Low	57.4
Org13	Provision of training programmes for safety managers	31	77.5	High	26	38.2	Low	52.8
Risk Assessment								
Risk1	Undertaking overall project risk assessments before project starts	37	92.5	High	38	55.9	Moderate	69.4
Risk2	Designing site rules and measures to mitigate assessed risks	38	95.0	High	32	47.1	Low	64.8
Risk3	Undertaking risk assessments for work packages before they start	38	95.0	High	45	66.2	Moderate	76.9
Risk4	Reviewing and updating risk assessments during construction	32	80.0	High	19	27.9	Low	47.2
Risk5	Informing employees about hazards on sites before work starts	38	95.0	High	56	82.4	**High**	87.0
Planning								
Plan1	Preparing H&S plans for every construction project	38	95.0	High	37	54.4	Moderate	69.4
Plan2	Provision of H&S insurance cover for sites	35	87.5	High	29	42.6	Low	53.7
Plan3	Pricing to cover H&S requirements for projects	38	95.0	High	17	25.0	Low	40.7
Plan4	Preparing method statements	36	90.0	High	42	61.8	Moderate	72.2
Plan5	Setting H&S performance targets	34	85.0	High	24	35.3	Low	56.5

Implementation									
Impl1	Implementing site H&S rules and measures	37	92.5	High	40	58.8	Moderate	71.3
Impl2	Amending and correcting H&S plans during construction	35	87.5	High	16	23.5	Low	47.2
Impl3	Rewarding workers for safe work behavior	38	95.0	High	22	32.4	Low	55.6
Impl4	Site inductions for workers	36	90.0	High	42	61.8	Moderate	72.2
Impl5	Training programmes for site workers	34	85.0	High	26	38.2	Low	55.6
Impl6	Carrying out site H&S inspections regularly	37	92.5	High	35	51.5	Moderate	66.7
Impl7	Provision of sanitation and welfare facilities on sites (e.g., toilets and canteens)	38	95.0	High	29	42.6	Low	62.0
Impl8	Provision of personal protective equipment	35	87.5	High	62	91.2	**High**	89.8
Impl9	Provision of first aid equipment on sites	36	90.0	High	34	50.0	Moderate	64.8
Impl10	Discipling workers for unsafe work behavior	34	85.0	High	22	32.4	Low	51.9
Impl11	Assigning H&S supervisor on site	26	65.0	Moderate	24	35.3	Low	46.3
Impl12	Conducting regular health check for employees	35	87.5	High	34	50.0	Moderate	63.9
Measuring & Reviewing Performance								
Meas1	Measuring H&S performance against targets	38	95.0	High	18	26.5	Low	52.8
Meas2	Reviewing and updating H&S plans after project completion	28	70.0	High	15	22.1	Low	39.8
Meas3	Keeping incident records on every project	34	85.0	High	32	47.1	Low	61.1
Meas4	Investigating the causes of incidents, accidents and near-misses	35	87.5	High	35	51.5	Moderate	64.8
Meas5	Publishing and sharing lessons learnt from accidents investigation	36	90.0	High	58	85.3	**High**	87.0
Auditing								
Aud1	Undertaking periodic safety management auditing	34	85.0	High	31	45.6	Low	60.2
Aud2	Use of external consultant for undertaking safety management auditing	28	70.0	High	11	16.2	Low	36.1
Aud3	Use of internal personnel for undertaking safety management auditing	33	82.5	High	54	79.4	**High**	80.6

The level number of implementation of H&S practices (Large enterprises/SMEs): High (42/6), Moderate (2/11), Low (1/28)

The standard of level: Low (0-49% frequency); Moderate (50-69% frequency); and High (70%+ frequency) (Manu et al., 2017; 2018)

Table 4 Association between **the Age** of the company and Implementation of OSH practices

OSH management Practices	**3-10 years**		**11-20 years**		**Over 20 years**		**Chi-Square**		**Cramer's V**	**Fisher's Exact Test**
	Obs. Count	Exp. Count	Obs. Count	Exp. Count	Obs. Count	Exp. Count	X^2 (df=2)	Asymptotic Significance		

Pol1	0	1	0.2	5	2.4	3	6.5	9.771[a]	0.008	0.302	**0.012**
	1	1	1.8	23	25.6	74	70.5				
Org 12	0	1	0.9	19	12.0	26	33.1	9.778 [a]	0.008	0.302	**0.004**
	1	1	1.1	9	16.0	51	43.9				
Impl 2	0	0	1.0	20	14.7	36	40.3	7.250 [a]	0.027	0.260	**0.017**
	1	2	1.0	8	13.3	41	36.7				
Impl 7	0	1	0.7	16	10.5	23	28.8	6.663 [a]	0.036	0.250	**0.016**
	1	1	1.3	12	17.5	54	48.2				

[a] x cells (y %, i.e., over 20%) have expected count less than 5.

Table 5. Summary of the level of implementation of OSH management practices in South Korea (Park, 2018) and comparison of overall level with three countries (Manu, 2017)

Categories	**Level of implementation of OSH management practices**			
	Low	**Moderate**	**High**	**Total**
Policy	1	-	1	2
Organising	5	7 (54%)	1	13
Risk Assessment	1	2 (40%)	2	5

Planning	1	3 (60%)	1	5
Implementation	2	7 (58%)	3	12
Measuring & Reviewing	1	3 (60%)	1	5
Auditing	1	1 (33%)	1	3
South Korea Total (Percentage)	12 (26.7%)	**23 (51.1%)**	10 (22.2%)	45 (100.0%)

Vietnam	7 (17.5%)	**20 (50.0%)**	13 (32.5%)	40 (100.0%)
Malaysia	**26 (65.0%)**	12 (30.0%)	2 (5.0%)	40 (100.0%)
Cambodia	**24 (60.0%)**	11 (27.5%)	5 (12.5%)	40 (100.0%)

Supplementary Data 1. Association between **BS OHSAS** of the company and Implementation of OSH practices

OSH management Practices		BS OHSAS 18001 Certified		BS OHSAS 18001 Non-Certified		Chi-Square		Cramer's V	Fisher's Exact Test
		Obs. Count	Exp. Count	Obs. Count	Exp. Count	X^2 (df=1)	Asymptotic Significance		
Pol1	0	1	4.1	9	5.9	4.314[a]	0.038	0.200	0.046
	1	43	39.3	55	58.1				
Org1	0	13	24.4	47	35.6	20.344	0.000	0.434	0.000
	1	31	19.6	17	28.4				
Org2	0	30	34.2	54	49.8	3.956	0.047	0.191	0.060
	1	14	9.8	10	14.2				
Org3	0	8	14.7	28	21.3	7.670	0.060	0.267	0.007
	1	36	29.3	36	42.7				
Org4	0	4	9.4	19	13.6	6.599	0.010	0.247	0.016
	1	40	34.6	45	50.4				
Org6	0	13	22.4	42	32.6	13.581	0.000	0.355	0.000
	1	31	21.6	22	31.4				
Org7	0	8	18.3	37	26.7	16.849	0.000	0.395	0.000
	1	36	25.7	27	37.3				
Org8	0	10	22.4	45	32.6	23.624	0.000	0.468	0.000
	1	34	21.6	19	31.4				
Org9	0	8	17.9	36	26.1	15.651	0.000	0.381	0.000
	1	36	26.1	28	37.9				
Org10	0	8	19.1	39	27.9	19.392	0.000	0.424	0.000
	1	36	24.9	25	36.1				
Org11	0	17	26.9	49	39.1	15.781	0.000	0.382	0.000
	1	27	17.1	15	24.9				
Org12	0	10	18.7	36	27.3	11.984	0.001	0.333	0.001

	1	34	25.3	28	36.7				
Org13	0	15	20.8	36	30.2	5.137	0.023	0.218	0.031
	1	29	23.2	28	33.8				
Risk1	0	8	13.4	25	19.6	5.358	0.021	0.223	0.033
	1	36	30.6	39	44.4				
Risk2	0	7	15.5	31	22.5	12.098	0.001	0.335	0.000
	1	37	28.5	33	41.5				
Risk4	0	11	23.2	46	33.8	22.988	0.000	0.461	0.000
	1	33	20.8	18	30.2				
Plan1	0	8	13.4	25	19.6	5.358	0.021	0.223	0.033
	1	36	30.6	39	44.4				
Plan2	0	13	20.4	37	29.6	8.380	0.004	0.279	0.006
	1	31	23.6	27	34.4				
Plan3	0	20	26.1	44	37.9	5.861	0.015	0.233	0.018
	1	24	17.9	20	26.1				
Plan5	0	10	19.1	37	27.9	13.058	0.000	0.348	0.000
	1	34	24.9	27	36.1				
Impl2	0	11	23.2	46	33.8	22.988	0.000	0.461	0.000
	1	33	20.8	18	30.2				
Impl3	0	6	19.6	42	28.4	28.542	0.000	0.514	0.000
	1	38	24.4	22	35.6				
Impl4	0	6	12.2	24	17.8	7.401	0.007	0.262	0.008
	1	38	31.8	40	46.2				
Impl5	0	13	19.6	35	28.4	6.675	0.010	0.249	0.011
	1	31	24.4	29	35.6				
Impl6	0	6	14.7	30	21.3	12.963	0.000	0.346	0.000
	1	38	29.3	34	42.7				
Impl7	0	8	16.7	33	24.3	12.336	0.000	0.338	0.001
	1	36	27.3	31	39.7				

Impl9	0	9	15.5	29	22.5	7.065	0.008	0.256	0.008
	1	35	28.5	35	41.5				
Impl10	0	12	21.2	52	52.0	12.961	0.000	0.346	0.000
	1	32	22.8	56	56.0				
Impl12	0	9	15.9	30	23.1	7.889	0.005	0.270	0.008
	1	35	28.1	34	40.9				
Meas1	0	9	20.8	42	30.2	21.346	0.000	0.448	0.000
	1	35	23.2	22	33.8				
Meas2	0	11	26.5	54	38.5	38.360	0.000	0.596	0.000
	1	33	17.5	10	25.5				
Meas3	0	8	17.1	34	24.9	13.396	0.000	0.352	0.000
	1	36	26.9	30	39.1				
Meas4	0	8	15.5	30	22.5	9.413	0.002	0.295	0.002
	1	36	28.5	34	41.5				
Aud1	0	8	17.5	35	25.5	14.501	0.000	0.366	0.000
	1	36	26.5	29	38.5				
Aud2	0	20	28.1	49	40.9	10.937	0.001	0.318	0.001
	1	24	15.9	15	23.1				

[a] x cells (y %, i.e., over 20%) have expected count less than 5.

Supplementary Data 2. Association between **Size of Company** and Implementation of OSH practices

OSH management Practices	**Less 10**		**11-50**		**51-100**		**101-200**		**201-500**		**Over 500**		**Likelihood Ratio**		**Cramer's V**
	O.C.	E.C.	O.C.	E.C.	O.C.	E.C.	O.C.	E.C.	O.C.	E.C.	O.C.	E.C.	Value	Asym. Significant	

Pol1	0	2	0.7	6	2.9	0	1.1	2	0.6	0	0.9	0	3.7	18.800	0.002	0.379
	1	6	7.3	25	28.1	12	10.9	5	6.4	10	9.1	40	36.3			
Org1	0	8	4.4	30	17.2	9	6.7	5	3.9	3	5.6	5	22.2	75.318	0.000	0.764
	1	0	3.6	1	13.8	3	5.3	2	3.1	7	4.4	35	17.8			
Org3	0	3	2.7	20	10.3	5	4.0	3	2.3	2	3.3	3	13.3	29.398	0.000	0.501
	1	5	5.3	11	20.7	7	8.0	4	4.7	8	6.7	37	26.7			
Org4	0	3	1.7	9	6.6	3	2.6	3	1.5	3	2.1	2	8.5	12.765	0.026	0.322
	1	5	6.3	22	24.4	9	9.4	4	5.5	7	7.9	38	31.5			
Org5	0	6	3.7	20	14.4	4	5.6	5	3.2	5	4.6	10	18.5	17.303	0.004	0.394
	1	2	4.3	11	16.6	8	6.4	2	3.8	5	5.4	30	21.5			
Org6	0	6	4.1	26	15.8	8	6.1	5	3.6	6	5.1	4	20.4	50.175	0.000	0.644
	1	2	3.9	5	15.2	4	5.9	2	3.4	4	4.9	36	19.6			
Org7	0	4	3.3	21	12.9	7	5.0	4	2.9	4	4.2	5	16.7	27.167	0.000	0.481
	1	4	4.7	10	18.1	5	7.0	3	4.1	6	5.8	35	23.3			
Org8	0	7	4.1	25	15.8	9	6.1	4	3.6	3	5.1	7	20.4	40.820	0.000	0.591
	1	1	3.9	6	15.2	3	5.9	3	3.4	7	4.9	33	19.6			
Org9	0	8	3.3	23	12.6	6	4.9	2	2.9	3	4.1	2	16.3	57.481	0.000	0.670
	1	4	4.7	8	18.4	6	7.1	5	4.1	7	5.9	38	23.7			
Org10	0	5	3.5	24	13.5	7	5.2	6	3.0	2	4.4	3	17.4	50.836	0.000	0.647
	1	3	4.5	7	17.5	5	6.8	1	4.0	8	5.6	37	22.6			
Org11	0	7	4.9	29	18.9	9	7.3	5	4.3	6	6.1	10	24.4	43.163	0.000	0.603
	1	1	3.1	2	12.1	3	4.7	2	2.7	4	3.9	30	15.6			
Org12	0	8	3.4	21	13.2	5	5.1	5	3.0	2	4.3	5	17.0	43.529	0.000	0.594
	1	0	4.6	10	17.8	7	6.9	2	4.0	8	5.7	35	23.0			
Org13	0	7	3.8	20	14.6	7	5.7	5	3.3	3	4.7	9	18.9	23.487	0.000	0.453
	1	1	4.2	11	16.4	5	6.3	2	3.7	7	5.3	31	21.1			
Risk1	0	7	2.4	15	9.5	2	3.7	3	2.1	3	3.1	3	12.2	30.074	0.000	0.514
	1	1	5.6	16	21.5	10	8.3	4	4.9	7	6.9	37	27.8			

Risk2	0	7	2.8	18	10.9	4	4.2	4	2.5	2	3.5	3	14.1	35.745	0.000	0.550
	1	1	5.2	13	20.1	8	7.8	3	4.5	8	6.5	37	25.9			
Risk3	0	2	1.9	15	7.2	2	2.8	3	1.6	1	2.3	2	9.3	22.172	0.000	0.444
	1	6	6.1	16	23.8	10	9.2	4	5.4	9	7.7	38	30.7			
Risk4	0	8	4.2	25	16.4	8	6.3	5	3.7	4	5.3	7	21.1	44.714	0.000	0.604
	1	0	3.8	6	14.6	4	5.7	2	3.3	6	4.7	33	18.9			
Risk5	0	3	1.0	4	4.0	1	1.6	3	0.9	0	1.3	3	5.2	11.125	0.049	0.341
	1	5	7.0	27	27.0	11	10.4	4	6.1	10	8.7	37	34.8			
Plan1	0	8	2.4	14	9.5	4	3.7	2	2.1	3	3.1	2	12.2	38.513	0.000	0.558
	1	0	5.6	17	21.5	8	8.3	5	4.9	7	6.9	38	27.8			
Plan2	0	3	3.7	21	14.4	6	5.6	4	3.2	5	4.6	11	18.5	12.443	0.029	0.335
	1	5	4.3	10	16.6	6	6.4	3	3.8	5	5.4	29	21.5			
Plan3	0	5	4.7	26	18.4	8	7.1	6	4.1	7	5.9	12	23.7	25.913	0.000	0.479
	1	3	3.3	5	12.6	4	4.9	1	2.9	3	4.1	28	16.3			
Plan4	0	4	2.2	16	8.6	2	3.3	3	1.9	2	2.8	3	11.1	21.896	0.001	0.439
	1	4	5.8	15	22.4	10	8.7	4	5.1	8	7.2	37	28.9			
Plan5	0	6	3.5	23	13.5	7	5.2	5	3.0	2	4.4	4	17.4	42.808	0.000	0.600
	1	2	4.5	8	17.5	5	6.8	2	4.0	8	5.6	36	22.6			
Impl1	0	5	2.3	15	8.9	4	3.4	3	2.0	1	2.9	3	11.5	23.310	0.000	0.448
	1	3	5.7	16	22.1	8	8.6	4	5.0	9	7.1	37	28.5			
Impl2	0	7	4.2	26	16.4	9	6.3	6	3.7	3	5.3	6	21.1	50.694	0.000	0.655
	1	1	3.8	5	14.6	3	5.7	1	3.3	7	4.7	34	18.9			
Impl3	0	7	3.6	26	13.8	7	5.3	5	3.1	2	4.4	1	17.8	70.927	0.000	0.742
	1	1	4.4	5	17.2	5	6.7	2	3.9	8	5.6	39	22.2			
Impl4	0	3	2.2	16	8.6	4	3.3	1	1.9	2	2.8	4	11.1	17.061	0.004	0.392
	1	5	5.8	15	22.4	8	8.7	6	5.1	8	7.2	36	28.9			
Impl5	0	7	3.6	21	13.8	5	5.3	6	3.1	3	4.4	6	17.8	35.294	0.000	0.549
	1	1	4.4	10	17.2	7	6.7	1	3.9	7	5.6	34	22.2			

Impl6	0	6	2.7	20	10.3	3	4.0	3	2.3	2	3.3	2	13.3	39.219	0.000	0.575
	1	2	5.3	11	20.7	9	8.0	4	4.7	8	6.7	38	26.7			
Impl7	0	5	3.0	24	11.8	6	4.6	3	2.7	2	3.8	1	15.2	54.139	0.000	0.653
	1	3	5.0	7	19.2	6	7.4	4	4.3	8	6.2	39	24.8			
Impl9	0	7	2.8	17	10.9	6	4.2	2	2.5	3	3.5	3	14.1	32.842	0.000	0.524
	1	1	5.2	14	20.1	6	7.8	5	4.5	7	6.5	37	25.9			
Impl10	0	8	3.9	26	14.9	5	5.8	4	3.4	3	4.8	6	19.3	50.284	0.000	0.637
	1	0	4.1	5	16.1	7	6.2	3	3.6	7	5.2	34	20.7			
Impl11	0	7	4.3	22	16.6	7	6.4	3	3.8	6	5.4	13	21.5	15.979	0.007	0.375
	1	1	3.7	9	14.4	5	5.6	4	3.2	4	4.6	27	18.5			
Impl12	0	5	2.9	16	11.2	6	4.3	5	2.5	3	3.6	4	14.4	24.513	0.000	0.456
	1	3	5.1	15	19.8	6	7.7	2	4.5	7	6.4	36	25.6			
Meas1	0	7	3.8	26	14.6	8	5.7	6	3.3	2	4.7	2	18.9	69.059	0.000	0.742
	1	1	4.2	5	16.4	4	6.3	1	3.7	8	5.3	38	21.1			
Meas2	0	7	4.8	28	18.7	10	7.2	4	4.2	3	6.0	13	24.1	36.428	0.000	0.557
	1	1	3.2	3	12.3	2	4.8	3	2.8	7	4.0	27	15.9			
Meas3	0	6	3.1	22	12.1	4	4.7	1	2.7	4	3.9	5	15.6	33.373	0.000	0.540
	1	2	4.9	9	18.9	8	7.3	6	4.3	6	6.1	35	24.4			
Meas5	0	5	2.8	19	10.9	6	4.2	2	2.5	2	3.5	4	14.1	27.103	0.000	0.484
	1	3	5.2	12	20.1	6	7.8	5	4.5	8	6.5	36	25.9			
Aud1	0	6	3.2	20	12.3	7	4.8	3	2.8	1	4.0	6	15.9	29.705	0.000	0.507
	1	2	4.8	11	18.7	5	7.2	4	4.2	9	6.0	34	24.1			
Aud2	0	8	5.1	26	19.8	12	7.7	4	4.5	7	6.4	12	25.6	43.237	0.000	0.584
	1	0	2.9	5	11.2	0	4.3	3	2.5	3	3.6	28	14.4			