Research on Economic Justification of Occupational Safety and Health (OSH) Implementation in the Construction Sector

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The ASEAN Secretariat
Jakarta

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Occupational safety and health (OSH) has been an important issue in the workplace, but it is even more critical in the construction sector. This industry is one of the most hazardous places to work, with accidents and fatality statistics substantially exceeding other occupational sectors. Such a phenomenon is a serious concern faced by both industrial and developing nations. A number of contributing factors can be attributed to this phenomenon; however, implementing an OSH programme has often been viewed to be ineffective and costly, leading to a hesitancy in implementing such in the workplace. To address this issue, the economic rationale can be considered as a viable approach for the justification of safety and health programmes in the workplace. The cost-benefit models have been more used recently as an approach that a company can utilise in ensuring that OSH investments provide good returns on investment. The cost-benefit analysis (CBA) compares the costs of implementing an investment (i.e., safety and health programmes) to the monetary value of outcomes that can be expected as shown by rigorous research. By employing this method, the management can identify and propose the most relevant programmes that can provide the greatest returns to the company.

Indonesia, started a pilot project aimed at evaluating the utility of this approach by collecting data from national construction companies in ASEAN Member States. The overall results of the project demonstrated the potential of using economic rationale in justifying an OSH programme. A preliminary workshop was held in Indonesia in 2018, which finalised the title of the project to "Research on Economic Justification of Occupational Safety and Health (OSH) Implementations in the Construction Sector". This project was endorsed by the 19th ASEAN Occupational Safety and Health Network (OSHNET) Coordination Board Meeting (CBM) held on 2-3 April 2018 in Cambodia and received funding support from the ASEAN Development Fund (ADF). Subsequently, a regional consultant from Indonesia was contracted for the project, with eight national experts recruited to collect national data. The regional report received ad-referendum endorsement by ASEAN-OSHNET on 21 November 2022.

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Foreword

COVID-19 pandemic has had a profound impact on nearly every aspect, not just a health crisis, but a social and economic one as well. It has disturbed the economies and labour markets globally. Construction sector without exception are also affected, and worsen the ASEAN region's economy. Currently, besides attention to economic recovery of construction sector, concern on OSH implementation in construction sector needs to be strengthened.

ASEAN OSHNET has a strong commitment in improving safety and health in the workplace. One of the major challenges in providing a safe and healthy working environment has to do with the costs of implementing occupational safety and health (OSH) programs in the workplace. Based on the ASEAN OSHNET Work Plan 2021-2025, Indonesia as Program Coordinator of Research has followed up "Research on the Economic Justification of Occupational Safety and Health (OSH) Implementation in the Construction Sector".

By saying thanks God, this research project has been completed. I express my gratitude to ASEAN Member States (AMS) and relevant parties who have contributed on the implementation and finalization of this research project. I appreciate and welcome the publication of the e-book "Research on Economic Justification of Occupational Safety and Health (OSH) Implementation in the Construction Sector" under ASEAN OSHNET.

From this research report it is found that providing much safer and healthier workplaces, could not be seen solely as an economic burden to the company, but most of OSH programs can actually be justified economically. Hopefully this publication will motivate the management of construction companies to carefully evaluate their OSH programs as well as a basis for policy maker to create national or regional policy on implementing OSH at construction sector.

Jakarta, December 2022
Director General of Labour Inspection and
Occupational Safety and Health Development
Ministry of Manpower Republic of Indonesia

Dr. Halyani Rumondang M.A.

Foreword

This Study on Economic Justification of Occupational Safety and Health (OSH) Implementation in the Construction Sector is a regional initiative in the Work Plan ASEAN Occupational Safety and Health Network (ASEAN-OSHNET) 2021-2025. It examined the implementation of OSH programmes in the construction sector and its economic gains across eight ASEAN Member States. The analysis showed that investments in occupational safety and/or health programmes in the construction workplace resulted in benefits that, from the economic perspective, are at least twice greater than the investment spent-- an affirmation that expenditures for OSH should be seen as an investment and not a cost.

I am pleased that this Study gives us a perspective on how an investment in OSH equipment and facilities is a responsible business practice that benefits workers, enterprises, Member States and ASEAN as a whole. As ASEAN economies recover from the COVID-19 pandemic, construction work is also expected to pick up pace. It is therefore important that the workers are well equipped for safety and protected from health risks. Building a safe and healthy workplace is a necessary condition for productivity. It is also pivotal in sustaining business and raising the company image and consumers' trust.

I am confident that this Study Report will provide useful insights for enterprises and governments in further raising the profiles of their OSH standards particularly in the construction sector. Appreciation goes to Indonesia for initiating this Study which contributes to the common agenda of an inclusive, resilient and sustainable ASEAN Community.

Ekkaphab Phanthavong
Deputy Secretary General of ASEAN for
ASEAN Socio-Cultural Community

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Executive Summary

Despite its substantial growth, the construction sector remains one of the most hazardous places to work. This sector typically ranks first with regard to the number of occupational incidents and fatality in the workplace. This has been a pressing issue faced by most of the countries within the Southeast Asia region. While a host of contributing factors could be attributed to this phenomenon, one of the major challenges in providing a safe and healthy working environment has to do with the costs of implementing occupational safety and health (OSH) programs in the workplace. Many construction companies are hesitant in implementing OSH programs due to the perception that such programs are costly. Such challenge can be overcome by carefully examining benefits of an OSH program that potentially outweigh its costs.

The current research project was conducted with the goal of evaluating the benefits of an OSH project in the construction sector from an economic perspective. This objective was achieved by inviting all ASEAN Member States (AMS) to participate in this research project; each AMS was responsible for collecting data from several construction companies. A national expert was appointed in each AMS, with a main responsibility of collecting survey data using a set of electronic questionnaires and, later, analyzed the results together with the Indonesian lead consultant. From eight AMS, a total of 48 construction companies agreed to provide their actual cost- and benefit-related data pertaining to their OSH program (it should be noted that Brunei Darussalam and Myanmar did not conduct national studies). By employing a benefit-cost analysis through calculation of benefit-cost ratio (BCR), it could be determined if the BCR of an OSH program is greater than 1, the program could be justified from an economic perspective, while a small BCR meant that the positive effects of an OSH program were negligible.

Results of this research project demonstrated that, across AMS, the BCRs ranged from 0.01 to 11.15, with the grand mean of 2.3. These results implied that some OSH programs could be difficult to justify (BCR of nearly 0) but, in contrast, the other programs could yield stark benefits (BCR much greater than 1). The average of BCR among AMS ranged from

0.84 (Singapore) to 4.18 (Viet Nam). Though it was not statistically significant, large construction companies tended to be represented by larger BCRs when compared to their smaller counterparts. These results showed that, while there were companies having difficulties in justifying their OSH programs, most of the OSH programs in this study were in fact beneficial from an economic point of view.

There are several implications that can be gained from this research project. First, most OSH programs can generally be justified from an economic point of view. Furthermore, this finding should be evident to construction companies that a carefully planned and designed OSH program can be implemented and executed. The prerequisite, however, is that all the costs and benefits resulting from a program can be meticulously identified

and quantified. Second, the BCR analysis requires that all costs and (especially) benefits can be transformed and quantified into monetary values, and it is clear when (within the time horizon) both the benefits are obtained, and the costs are disbursed. This is often challenging, particularly since certain benefits are difficult to quantify in monetary terms.

Therefore, it is imperative that a construction company need to have individuals (or external consultants) with satisfactory knowledge on different concepts and technical aspects of safety, risks, and economic analysis. Third, the characteristics of an OSH program are highly dependent on the type of the structure being built. Companies with projects involving high-rise buildings may have substantially different OSH programs compared to those responsible for maintaining road infrastructures. In addition, some companies are involved with short-term projects (such as building houses), while others deal with long-term construction projects (such as high-speed railway infrastructure). All these will result in differences in types of costs and benefits that need to be examined and differences in the project time horizon, which consequently lead to differences in how the economic analysis is performed. Lastly, while the same methodology can be employed across AMS, the nature of the industry could be different across nations resulting in differences in the focus of the OSH programs. For instance, OSH programs that enforce workers to follow good safety practices may not be a priority in Singapore due to stronger adherence to national laws and regulations. Moreover, the construction sector in Brunei Darussalam may be characterized by fairly low fatality rate, but the prevalence of migrant workers with different cultural background may characterize workplace safety and health issues. The point is that each AMS may have unique national culture and characteristics that can influence how an OSH program in the construction industry can be suitably and effectively designed and implemented.

This study was aimed at evaluating the implementation of an economic (benefit-cost) analysis for OSH programs in the construction sector. It can be concluded here that, while the implementation of an OSH program in this sector is usually viewed as costly, this study found that most of OSH programs can actually be justified economically. This is true particularly when all costs and benefits have been identified, quantified, and monetized carefully. This collaborative effort has provided evidence that careful economic analysis can actually justify OSH programs, and the corresponding methodologies can be used as a viable approach in justifying expenses associated with expensive OSH investments. Through careful economic evaluation, managers and project owners should not be hesitant in designing and providing much safer and healthier workplaces, even though the resulting OSH programs could initially be seen as an economic burden to the company. Safe and healthy workers should be used as a competitive advantage that will lead to more productive and, eventually, more sustained businesses in this competitive world.

1. Introduction

The economic growth among members of the Association of Southeast Asian Nations (ASEAN) has generally been strong in the past years, despite differences in economic recovery from COVID-19 pandemic. World Bank data during 2016-2021 (data.worldbank.org) show an average growth of roughly 3.2%, with Viet Nam characterized by the largest growth (5.58%) while Brunei Darussalam associated with the smallest growth (0.38%). Except for Brunei Darussalam and Thailand, all other ASEAN Member States (AMS) have an average growth of greater than 2%. Note, however, that a decreasing trend is observed for Myanmar, with a substantially negative growth (-18%) found in 2021.

The construction industry within the Southeast Asian region has also generally enjoyed substantial growth in the past decade, although the recent trend has been largely influenced by the COVID-19 pandemic. During the period of 2012-2016, data from the six largest economies in ASEAN (PwC, 2017) shows a national average growth between 4.3 to 12.6% (a grand mean of 9.3%). While much slower growth has been expected due to the pandemic, the past-pandemic projection of more than 370,000 construction enterprises across ASEAN countries seems to be optimistic.

For Indonesia, for example, the growth of this sector was nearly 6% in 2019 (Soemardi & Pribadi, 2018), largely due to construction of dams, public roads, toll roads, and bridges. The construction sector is the third-largest contributor to Indonesia's GDP, and the investments are among the largest out of all construction investments in Asia. In 2020, there were approximately 159.3 thousand construction establishments active in Indonesia. Indonesia's construction industry was experiencing increased growth due to increases in infrastructure construction and there were approximately 8.07 million people working in the construction industry (Soemardi & Pribadi).

For the Philippines, report by the World Bank has indicated an increasing trend in construction due to government's strategy of "Build, Build, Build" infrastructure program. The growth decelerated due to the pandemic but is expected to increase in 2022. The total value of construction contracts in 2020 amounted to PhP 275.81 billion, or USD 5.4 billion (JD Supra, 2021). The Philippine government aims to spend at least 7% of its gross domestic product for construction (Feria & Ocampo, 2020).

Singapore's economy has also been driven by construction work, projected to be between S$ 27 billion and S$ 32 billion in 2022, with the public sector expected to contribute about 60 per cent of the total demand, as reported by the Building and Construction Authority (BCA). The construction demand in the public sector is projected to be between S$16 billion and S$19 billion, supported by the strong pipeline of housing projects including those under the Home Improvement Programme, as well as healthcare developments and infrastructure works such as the Cross Island MRT Line (Phase 1). Meanwhile, the private sector construction demand is expected to reach between S$11 billion and S$13 billion this year, comparable with the volume in 2021 (BCA, 2022).

The forecast for Viet Nam is a bit greater than 8.7%, considered to be the best performing nation within the Asia-Pacific region (Research and Markets, 2022). As an important pillar of the Viet Nam economy, the construction sector accounted for an increasing contribution to the gross domestic product while being one of the largest employers in Viet Nam. According to the 2021 Economic Census, in terms of the economic sector, the industry and construction sector accounts for the second largest proportion in terms of the number of units and employees (after the service sector). Industry and construction enterprises were 211.5 thousand enterprises in 2021, accounting for 30.9% of the total number of enterprises.

In Lao PDR, the construction sector is among the largest and fastest growing sectors in the industry. According to the Lao Statistics Bureau (LSB), the construction sector contributed about 7.98 percent of the country's GDP in 2019 and 8.61 percent in 2020. The sector's growth rate was at around 21 percent in 2019 and dropped to about 14.5 percent in 2020, mainly due to COVID-19. In 2020, there were 552 enterprises in the construction sector, with a combined registered capital of around USD 1.26 billion. While the industry has been hit hard worldwide due to the pandemic, the growth of the industry in Malaysia is predicted to recover by 14.6% by expansion in 2021 (Market Research South East Asia, 2021).

The construction industry in Brunei Darussalam recorded an annual growth of 3.2 percent in 2020, despite facing supply chain disruptions due to the COVID-19 pandemic. With limited labor force, however, the country depends on migrant workers for construction projects who are willing to work extra hours with relatively lower wages (Santoso, 2009). Migrant workers made up 78 percent of the total workforce in the construction industry, according to DEPS's Labour Force Survey 2019.

Myanmar's construction industry is expected to shrink by 7.7% in real terms in 2021, down from a marginal decline of 0.5% in 2020. The industry's output in 2020 was affected by the outbreak of the coronavirus disease (COVID-19) pandemic. In 2021, the weakness in the industry is expected to be further exacerbated by the ongoing political crisis and its impact on foreign investment and construction progress. The construction sector employs over 1.2 million people, which accounts for 5.5% of the working population. The new Occupational Safety and Health (OSH) Law in March 2019 is expected to pave the way for the first legally-established health and safety standards in the country. Meanwhile, most workplaces in Myanmar are still operating below international health and safety standards and construction incidents are common and widely reported. However, the country's health, safety and environment data and workplace accidents statistics are difficult to obtain.

In Malaysia, the construction industry is very important to the country, contributing about 4% of the nation's Gross Domestic Products (GDP). The economic outlook for the construction industry is encouraging and is projected to increase by 11.5% in 2022, given several government-backed engineering construction projects.

Meanwhile, in Thailand, construction industry expanded by an estimated 2.7% in real terms in 2021 – up from an annual growth of 1.3% in 2020, supported by investments in

renewable energy, residential, and infrastructure construction projects. According to the National Economic and Social Development Council (NESDC), the constructionindustry's value added declined marginally by 0.9% year on year (YoY) in the fourth quarter of 2021, compared with a 4.2% contraction in the previous quarter. The decline in COVID-19 infections and the easing of restrictions is expected to support the industry's output in the coming quarters. The industry's output over the forecast period will also be supported by investments in transport infrastructure projects.

Despite the significant and potential growth, the construction industry in many developing nations is probably a sector that has received only marginal attention with respect to safety and health in the workplace (Buniya, et al., 2021). The construction sector typically ranks first with regard to the number of occupational incidents and fatality. This is true for Indonesia (Ghuzdewan & Damanik, 2019) and Singapore (Singapore Ministry of Manpower, 2020). Although data with respect to work-related incidents are not available in Lao PDR, this issue has actually been a major concern among government officials and stakeholders (Sengpaseuth, 2022). The construction industry in Cambodia has been booming due to foreign investments, but this rapid growth is also associated with poor construction quality and high incidence rate. In 2009, the International Labour Organization (ILO) estimates that more than 1.500 workers are killed each year in Cambodia, with the majority occurs in the construction sector. Based on 2019 data by Philippine Statistics Authority, a total of 37,513 occupational accidents were reported in all industries in the Philippines in 2019. In Malaysia, the number of occupational accidents were 32,674 cases in 2020, with the number of occupational fatalities being 312 cases (bin Zaini, 2022).

Occupational safety and health in construction is also a pressing issue in other ASEAN Member States (AMS). In Malaysia, for instance, recent data demonstrate that just over one-quarter of workplace fatalities are from construction-related incidents. The construction industry in Malaysia has an appreciably higher rate of fatality (6.9 per 100,000 workers). According to Viet Nam's Ministry of Labour, Invalids and Social Affairs (MOLISA)'s annual report on occupational accidents from 2013 to 2021, occupational accidents in the construction sector always rank first in terms of total number of fatal accidents and total number of deaths for 6 consecutive years. Moreover, report from Indonesia's National Social Security Agency for Employment in 2020 indicated more than 177,000 occupational accidents in the construction industry. Note that the actual number could be higher due to the fact that not all workers were registered in the system. All these statistics clearly demonstrate that workplace incidents in the construction industry are a major concern, and appropriate occupational safety and health (OSH) strategy and programs should be sought to ameliorate the problems.

It should be noted, however, that implementing OSH program for this sector has been a challenge. It is not uncommon for companies to only implement OSH programs at the minimum level as required by applicable laws and government regulations (Tang & Daniel, 2020). Some of the factors that cause hesitancy in implementing much safer and healthier working environment in the construction sector could be attributed to the fact that many companies employ subcontractors. These subcontractors have to

run their business efficiently, and often seek ways to minimize costs for the perceived 'non-critical' expenses. To minimize operating costs, they prefer hiring workers with the minimum levels of education needed, which often results in lower workplace safety and health awareness. In addition, these companies are often rushed in completing the projects due to a number of factors, including the complexity of a construction project, inadequate budgeting, poor scheduling, missing deadlines, or the scarcity of certain supplies and resources. Another important factor is the fact that there is a perception that many OSH programs are costly, which does not justify their implementation in the workplace. Management often fails to realize that there could be significant benefits resulting from high quality OSH programs. It is generally accepted that implementing an OSH program can be difficult unless the obtained benefits are substantial.

The general practice is that safety and health programs in the workplace can be implemented only if their benefits (i.e., savings) outweigh the actual costs of implementing the programs. Costs of implementing safety and health programs by identifying the benefits can be challenging due to the difficulties in correctly classifying and quantifying the benefits. The ILO suggests the use of direct and indirect costs. Direct costs associated with an injury (e.g., medical costs or property damage) can be easily identified. Other costs, however, are more difficult to estimate such as indirect and hidden costs (e.g., human resource personnel handling the accident). Moreover, benefits gained from a program can be intangible and qualitative in nature. This should be quantified and, further, considered as additional justifications to a safety and health program.

Regardless of the aforementioned phenomena, it is generally accepted that economic rationale has been considered as a viable approach for the justification of safety and health programs in the workplace. A frequently used method is called the cost-benefit models (Reniers & Brijs, 2014), an approach that a company can utilize in ensuring that investing in health and safety programs can result in a good return on investment (Ikpe et al., 2008). The Cost Benefit Analysis (CBA) compares the costs of implementing an investment (i.e., safety and health programs) to the monetary value of outcomes that can be expected as shown by rigorous research (Newnan et al., 2012). Using such method, management can identify and propose the most relevant program that can provide the greatest returns to the company. Similarly, the Net Present Value (NPV) can be used for making investment decisions; a positive NPV, for example, can justify a strategic investment (Newnan et al., 2012). Based on these methods, the management can determine if it is worth conducting the program or not.

ASEAN has a strong commitment in improving safety and health in the workplace, by establishing the Occupational Safety and Health Network (OSHNET). This commitment is reflected in the ASEAN-OSHNET Work Plan 2021-2025, objective of the ASEAN Labour Ministers' Work Programme 2021-2025 as the overarching guiding document, as well as the relevant strategic measures in the ASCC Blueprint 2025. Indonesia, with the support of Malaysia and Singapore, is the country coordinator for the Joint Research on Risk and Economic Benefit of Occupational Safety and Health. Accordingly, a pilot project was conducted by Indonesia aiming at evaluating OSH programs among a

few construction companies from an economic perspective. Findings of this study of 10 construction companies in Indonesia demonstrated the benefit-cost ratios (BCRs) ranging from 0.7 to 1.6. It was also revealed that a number of challenges were found in collecting the data and quantifying the effects of an OSH program. Nevertheless, this project demonstrated the potential of using economic rationale in justifying an OSH program. Lastly, a preliminary workshop was held in Indonesia in 2018, which finalized the title of the project to "Research on Economic Justification of Occupational Safety and Health (OSH) Implementation in the Construction Sector". This project was later endorsed in 2019 during the 19th ASEAN-OSHNET CBM held in Cambodia. Subsequently, it was agreed that the project would be funded by the ASEAN Development Fund.

2. Research Objectives

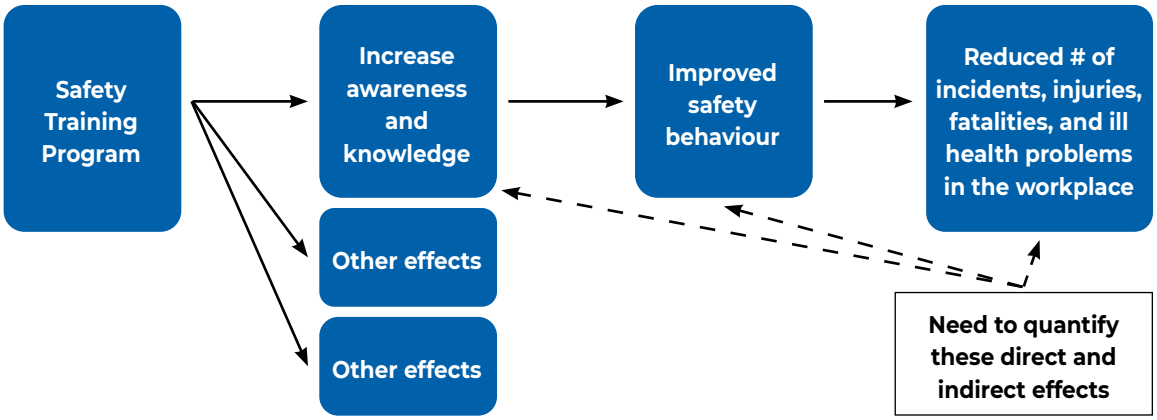
The present research project was aimed at conducting a systematic approach in determining the benefit of occupational safety or health program in the construction sector from an economic perspective, with data to be collected from all AMS. Through this project, it was expected that each AMS will gain knowledge and experience on how economic rationale can be employed to justify the implementation of a safety or health program in the workplace. This understanding can be used further in persuading and motivating the management of national construction companies in carefully evaluating their OSH programs. It is hoped that each AMS can gain valuable insights on the current state of safety and health in each country and learn success factors as well as challenges faced when implementing safety and health in the workplace. Lastly, findings from this study can shed some light on how to carefully design OSH programs that will reduce safety and health risks, while satisfying the economic criteria. Each AMS was expected to participate in this joint research project and, together, collect and analyze data obtained from six (6) construction companies, representing small (0-49 workers), medium (50-200 workers), and large-size (>200 workers) companies.

3. Research Procedure

This research project specifically addressed the construction industry because the construction sector is developing rapidly in many developing nations (Alaloul, et al., 2021). Each national expert (NE) was responsible for collecting data from construction companies. Eight AMS, notably Cambodia, Indonesia, Lao PDR, Malaysia, the Philippines, Singapore, Thailand and Viet Nam, participated in the national researches which were conducted by the respective NE. The national researches started in August 2021 and were able to obtain data sets from a total of 48 construction companies in those eight AMS.

A set of questionnaires (Appendix 1) was given to each company respondent by the NE. Based on preliminary discussions with the NE, each company proposed and selected one major OSH program that had been done in the past. The company was required to provide costs and benefits that were relatively easy to be explicitly stated and quantified. There should be a strong rationale justifying why the program had been implemented. The company management should also ensure that they had all the data pertaining to the actual costs spent (and the time when the money was disbursed) for this particular program. Further discussion with the NE addressed all potential benefits and costs saved resulting from the implementation of the program. Figure 1 provides an example of how an OSH program could be conceptually transformed into quantified effects (HSE, 2011). The figure depicts an OSH program that can result in conducive behavior and work environment that, in turn, leads to reduced number of incidents, fatalities, and ill-health problems. All cost and benefit calculations follow those described in Newnan et al. (2012). The calculation of benefit for BCR is calculated with Present Worth of Benefit, we sum the benefits with their value at month-0 of the project. Direct and indirect benefits are calculated under the same classification of benefit. The benefits used in BCR calculation are productivity improvement, saving on damaged products, saving on material used, saving on maintenance, staff commitment improvement, and company's image improvement. The cost for BCR is calculated with Present Worth of Cost, we sum the costs with their value at month-0 of the project. We then calculate the benefit-cost ratio with Present Worth of Benefit to Present Worth of Cost ratio. We can compare the BCR across companies with additional calculation of BCR by adding dummy timeframe to uniform the project life. As of now, we can only do the classification of BCR and their analysis.

Figure 1. An example of how an OSH program translates into quantified effects.



With the support of the lead consultant from Indonesia, a preliminary cost-benefit analysis was performed and provided to the NE as a basis for developing a national/country report. Whenever necessary, each NE conducted an in-depth discussion with company representative(s), to ensure that the results were acceptable. Each NE was responsible for developing a national report, which in turn was used by the lead consultant in preparing the final report. The lead consultant performed further statistical analysis (e.g., analysis of variance) as a means to answer several underlying research hypotheses. It should be noted that NE performed a qualitative analysis based on descriptive data (obtain from the six companies), whereas the lead consultant conducted the statistical analysis based on all the data collected. The lead consultant performed a literature review as well to complement the national reports and to fill up the information gap in absence of national reports of Brunei Darussalam and Myanmar. The lead consultant was also responsible for drawing conclusions based on the aggregated data.

It is necessary to highlight the challenges encountered in conducting this region-wide research. Some NEs faced difficulties in finding and having access to construction companies willing to cooperate and share information. The pandemic was also a factor that affected the research work particularly on the communications of NEs with construction companies to further discuss the analysis.

4. Results

Workplace fatality is a major concern around the world, as also an important issue faced by all AMS. In 2005, the average global fatality rate was 14.0 per 100,000 workers. The statistics in 2006 was 2.9 (per 100,000 workers) in Finland, 5.2 in the U.S., 9.8 in Singapore, and 18.3 in Malaysia (Win et al., 2018). Construction, in particular, has been shown to be the most dangerous sector, with hazards including falls from height, struct by moving objects, and crashes associated with heavy vehicle and machinery operations. While almost all AMS have their own OSH acts and regulations, the Implementation and enforcements are often lacking. Economic rationale (such as benefit-cost analysis) can be used as a viable approach in ensuring effective OSH Implementation in the workplace.

Cost-benefit approach has been employed in other sectors, such as the road transport (Elvik, 2001; 2003), petroleum industry (Gonzalez et al, 2016; Reniers et al., 2016; Talarico et al., 2016), manufacturing (Guimaraes et al., 2012; Rodezno, 2005), and the service sector (Ramos et al., 2015). The aim of Elvik's papers was evaluating the applicability of cost-benefit analysis as an aid in making decisions pertaining to road safety measures. The use of such approach has received criticism, particularly if it is applied toward problems involving basic human rights. It was noted, however, that economic justifications are actually a rationale decision that can be logically applied in a variety of cases. Early work (see for example Leonie & Tavenas, 1996) demonstrated that such approach could be used as a basis in preventing workplace accidents. Hendrik (2003) discussed a number of factors that can lead to successful implementation of cost- benefit analysis. His work further described classifications of costs and benefits based on a number of ergonomic projects in a variety of fields. It was concluded that the cost- benefit analysis was indeed beneficial, as exemplified by successful interventions. Cost justifications, though difficult, have also been employed in evaluating the utility of public policy (Sartori, 2015).

This joint research project was motivated by the fact that implementing an OSH program in the construction industry is difficult. Project owners and managers will often only implement bare programs required by national and local regulations. They typically view an OSH program as costly and is not necessarily (and directly) effective in improving safety and health in the workplace. This phenomenon is also exacerbated by the use of sub-contractors and low-skilled labors who are fairly easy to replace when a workplace injuries and fatalities occur. The present collaborative research generally aimed at investigating how to justify an OSH program in a construction sector, particularly from an economic perspective. The rationale is that implementing an OSH program is generally difficult, and getting the proposal accepted and approved by the management is typically challenging. The management (and all relevant stakeholders) usually wants to know if an OSH program is really needed, and if its implementation is cost effective. This means that all proposed OSH programs should be justified, at least from an economic perspective.

The BCR analysis requires that all benefits (and costs) can be transformed into monetary values, and it is exactly clear when (within the time horizon) both the benefits are obtained, and the costs are disbursed. In this research, costs included all expenses associated with implementing an OSH program. This included procurement, installation, operating the

system, and other additional costs pertaining to OSH risk management. These items were relatively easy to quantify, although the procedure should be done with care. In contrast, determining the advantages of OSH implementation in the workplace can be fairly difficult, such as when determining the costs avoided due to the implementation of an OSH program (e.g., first aid, hospitalization, accident investigation, litigation, loss time, etc.). A relatively complete list of costs and the corresponding calculations can be found in HSE (2011; 2020).

4.1. Overviews of the Samples Across AMS

The construction companies participating in this research had been involved in different construction projects, including public facility, oil, gas, mining industry, housing, commercial, office building, manufacturing, electric power, institutional, hotel, and others. The projects studied in this research ranged from PPE, safety audit, training, supervision, campaign, and hazard identification & risk control.

Table 1 shows data collection status from each NE, along with the number of respondents and company types from each participating AMS. It was the intention of the project to collect data evenly across company size, but the actual circumstances did not allow for this scenario to happen. Each NE was eventually given some sort of a leeway in determining which companies could participate in the project. This was particularly due to the limited NE's ability in having access to different types of construction companies required in this research. This had been considered acceptable considering the time limitation that each NE had. Table 2 shows the BCR and NPV for each project. A BCR greater than one (i.e., positive NPV) means that the selected OSH program results in overall positive effects (costs avoided + benefits > OSH-related expenses). However, according to Newnan, Eschenbach, and Lavelle (2009), a BCR lower than one means that the cost expended by the program is bigger than the benefit received. This implies that the program is not beneficial in economic terms.

Table 1. Data collected from each national expert based on company size.

No.	Country	Company Size			Total
		Small	Medium	Large	
1	Brunei Darussalam	0	0	0	0
2	Cambodia	1	3	1	5
3	Indonesia	3	1	2	6
4	Lao PDR	1	5	0	6
5	Malaysia	1	3	4	8
6	Myanmar*	-	-	-	-
7	Philippines	3	2	2	7
8	Singapore	0	2	3	5
9	Thailand	1	3	2	6
10	Viet Nam	1	1	3	5
Grand Total					**48**

*Myanmar did not participate in this research project.

A total of 48 data collected from each national expert, with 11 small companies (0-49 workers), 20 medium companies (50-200 workers), and 17 large companies (>200 workers). Brunei Darussalam participated in this research, but did not manage to collect any data. Originally, it was requested to collect data from six companies, two from each company size (small, medium, and large). Unfortunately, national experts found it difficult to collect data as requested, and therefore 5 data from each AMS are accepted. Additionally, Lao PDR could not obtain data from any large company, while Singapore could not obtain data from any small company.

Table 2. BCRs and NPVs associated with each OSH project.

Code	Country	BCR	NPV
ID1	Indonesia	6.086	$11,889.17
ID2	Indonesia	4.205	$23,663.63
ID3	Indonesia	0.929	$(351,130.90)
ID4	Indonesia	0.472	$(25,790.07)
ID5	Indonesia	1.312	$190,506.39
ID6	Indonesia	1.694	$2,375.96
KH1	Cambodia	1.246	$8,141.35
KH2	Cambodia	0.134	$(1,248,057.10)
Kh3	Cambodia	1.426	$42,121.47
KH4	Cambodia	1.796	$67,237.82
KH5	Cambodia	5.759	$164,423.41
LA1	Lao PDR	0.713	$(95,076.96)
LA2	Lao PDR	1.361	$29,063.75
LA3	Lao PDR	1.365	$47,201.41
LA4	Lao PDR	0.854	$(9,373.96)
LA5	Lao PDR	2.007	$101,650.58
LA6	Lao PDR	2.442	$36,449.49
My1	Malaysia	1.380	$22.62
MY2	Malaysia	1.595	$1,289,078.30
MY3	Malaysia	5.122	$8,287,313.60
MY4	Malaysia	1.624	$1,064,396.48
MY5	Malaysia	1.139	$356,070.98
MY6	Malaysia	5.327	$8,364,694.48
MY7	Malaysia	1.377	$2,819,111.12
MY8	Malaysia	4.644	$8,080,170.67
Ph1	Philippines	0.012	$(2,032,635.26)
PH2	Philippines	0.343	$(61,388.53)
PH3	Philippines	1.249	$6,410,896.41
PH4	Philippines	1.234	$394,441.35
PH5	Philippines	1.218	$1,566.41
PH6	Philippines	11.145	$847,664.01
PH7	Philippines	0.653	$(5,871.13)
SG1	Singapore	3.105	$2,694,523.84
SG2	Singapore	0.426	$(3,507,787.71)
SG3	Singapore	0.649	$(496,716.56)
SG4	Singapore	1.370	$999,285.28
SG5	Singapore	0.024	$(15,052,647.28)
TH1	Thailand	3.966	$3,710,061.42
TH2	Thailand	4.285	$169,515.77

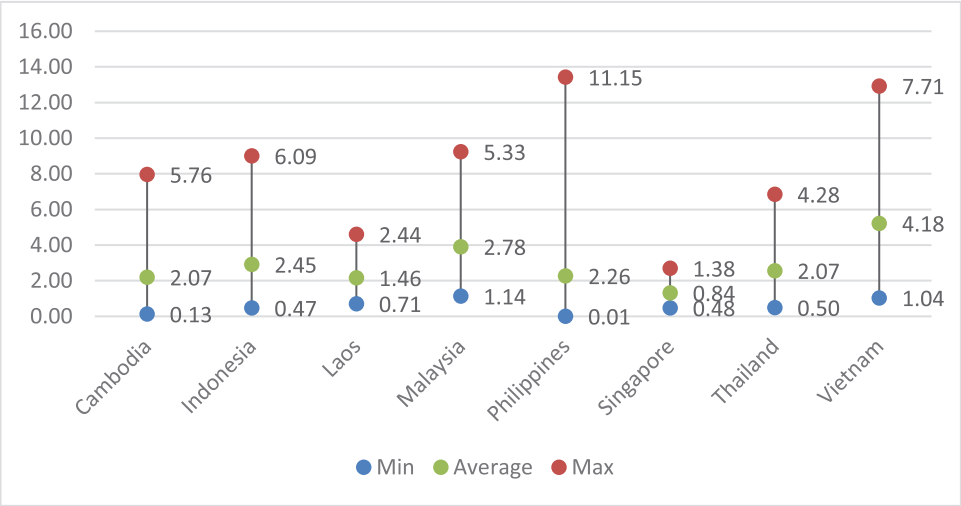
TH3	Thailand	0.548	$(349,865.93)
TH4	Thailand	0.069	$62,116.95
TH5	Thailand	0.852	$(71,842.80)
TH6	Thailand	0.499	$(316,265.57)
VN1	Viet Nam	7.710	$243,266.33
VN2	Viet Nam	3.799	$229,559.57
VN3	Viet Nam	2.732	$200,790.69
VN4	Viet Nam	5.630	$229,380.01
VN5	Viet Nam	1.044	$1,902.52

A very small BCR (nearly zero) was shown from PH1 project, meaning that the positive effects of the OSH program were negligible. In contrast, a substantially large BCR (11.1) was obtained from PH6 project, implying that the benefits of the OSH program far outweighed the costs spent for the program. Table 3 and Figure 2 show the BCRs for each participating country. Malaysia and Viet Nam are the only AMS with all BCR values greater than one.

Table 3. BCRs from each participating country.

Country	BCR		
	Min	Max	Average
Cambodia	0.13	5.76	2.07
Indonesia	0.47	6.09	2.45
Lao PDR	0.72	2.45	1.46
Malaysia	1.14	5.33	2.78
Philippines	0.01	11.15	2.27
Singapore	0.02	3.11	1.11
Thailand	0.50	4.28	2.07
Viet Nam	1.04	7.71	4.18

Figure 2. Minimum, maximum, and average BCRs of each country.



It was hypothesized in this study that there would be significant differences in BCR across company sizes. Large construction companies, in particular, might have ample resources leading to more effective OSH program. In contrast, small-sized company may not have the luxury of selecting a variety of OSH programs due to limited budget, resulting in relatively smaller BCR. This phenomenon, however, was not the case here. While the large-sized company was associated with the greatest mean BCR (2.95), the second greatest mean BCR (2.34) was obtained from small-sized enterprises (see Fig. 3). Middle-sized company was characterized with the smallest mean BCR (1.67). These differences were not significant from a statistical point of view ($p = 0.221$). No explanation can be offered here why such a phenomenon occurred, other than the possibility that large-sized company could formulate a much wider selections of OSH programs and select ones that were more efficient from an economic perspective.

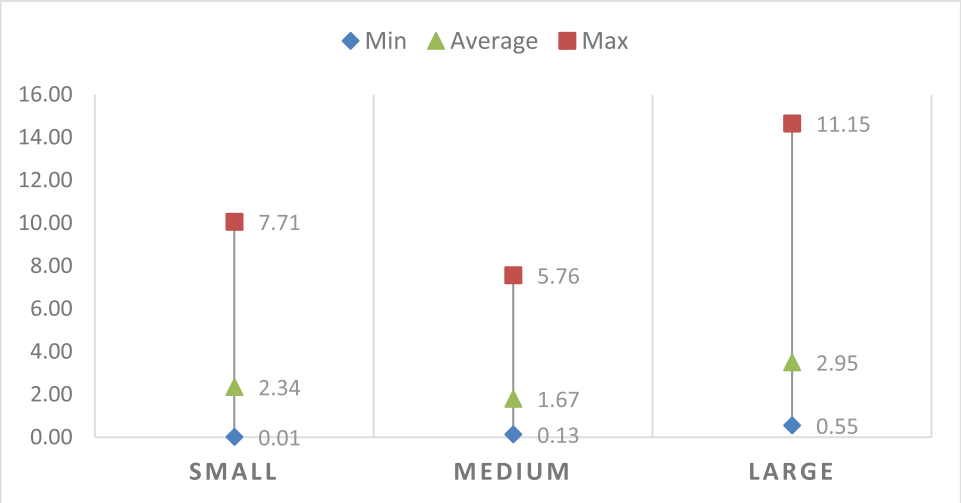
It should be noted that the size of the construction company was not associated with differences in lost time incident frequency rate (LTIFR) ($p = 0.592$). It was also of interest of this study to determine if the investment associated with an OSH program was related with BCR. This study found that this was not the case. The larger the investment did not guarantee a greater return (i.e., sum of all costs avoided and benefits). For instance, the largest investment in OSH program is $5,785,714.29 with BCR of 1.074 (one company from Malaysia). Meanwhile, the largest BCR is 10.475 with $27,000 of investment (one company from the Philippines).

It was hypothesized in this study that there would be significant differences in BCR across company sizes. Large construction companies, in particular, might have ample resources leading to more effective OSH program. Figure 3 shows the tendency that large companies were associated with greater average BCR. However, the result was not significant from a statistical point of view ($p = 0.176$). Note that the size of the construction company was not associated with differences in lost time incident frequency rate (LTIFR) ($p = 0.64$). It was also of interest of this study to determine if the investment associated with an OSH program was related with BCR. This study found that this was not the case. The larger the investment did not guarantee a greater return (i.e., sum of all costs avoided and benefits).

Table 4. BCRs among company sizes

Company Size	BCR		
	Min	Max	Average
Small	0.01	7.71	2.34
Medium	0.13	5.76	1.67
Large	0.55	11.15	2.95

Figure 3. Comparison of BCRs across company size.



Across the eight AMS participating in this research project, the grand mean of the BCR is approximately 2.3. This clearly means that any investments in occupational safety and/or health programs in the construction workplace will result in benefits that are double than the costs expended. Note that this average value was true for Cambodia, Indonesia, Malaysia, Thailand, and the Philippines. Relatively lower average BCR was found for Lao PDR (average BCR = 1.46) and a mean BCR of less than 1 was found for Singapore (average BCR = 0.84). Malaysia and Viet Nam are the only AMS with positive NPV across all the projects being studied. The Philippines had a construction company with the least favorable condition (a BCR of nearly zero), but at the same time also had a company with a safety/health program that was associated with the greatest return (BCR = 11.1). The lack of samples and different data quality provided by each National Expert may lower the aggregate data quality. However, that situation did not cancel the findings in this report.

4.2. Analysis Across AMS

Brunei Darussalam. Brunei Darussalam is characterized by a growth in the construction sector which is labor-intensive. The population is about 380,000 people, most of whom are of ethnic Malay. The country produces largely oil and gas as the major contributor of the GDP. With limited labor force, however, the country depends on migrant workers for construction projects who are willing to work extra hours with relatively lower wages (Santoso, 2009). Successful OSH projects will also depend on the multi-ethnic groups of workers, each having its own cultural background. A study by Win et al. (2021) showed that the 56.4% of non-fatal accident occur in the construction industry, which mostly involved migrant workers. Additional study also concluded this sector with the highest (60% of all industries) number of fatalities (Win et al., 2018), with a large number of victims are Indonesians. The fatality rate is roughly 4 – 6 per 100,000 workers, comparatively lower than most other AMS. More than half of the workplace fatalities are related to factors such as falls and structs by object. It is not known if

OSH programs are developed with BCR in mind; however, the methodology and findings from this study can be employed in evaluating which (and types of) OSH programs can be successfully implemented.

Cambodia. All construction companies recruited for this research project have completely implemented the OSH program. Based on the BCR value obtained from all five construction companies, there was one company with an extreme BCR value of 5.75 which indicated that this company has performed OSH program comprehensively, cost effectiveness and has produced higher benefit compared to the costs spent. This extreme BCR value might be due to the higher value of the investment cost on the OSH program. Investment in the OSH program will raise awareness and improve workplace safety. Another three companies, Exchange square, Tribe Hotel, and MUD-PPCC have obtained the BCR value of 1.24, 1.79, 1.42, respectively. These 3 companies with the BCR value greater than 1 were considered that the OSH program is acceptable with the positive signal. However, there was one construction company that obtained the lowest BCR value of 0.13. This result might be due to the lower investment to the OSH program (2% from the project value) compared to the duration of the project and project size.

Based on the type of OSH program, there were 3 companies that held OSH campaigns and 2 companies that held OSH training. Interestingly, the training program resulted in a better BCR (average: 3.59) and lower average %OSH investment than campaign (average BCR = 1.06). This shows that training can be viewed as an effective strategy in creating a better safety culture in the companies.

Indonesia. In general, the construction companies being studied have implemented OSH program with varying quality and quantity. This can be seen from the difference of investment value of implementing OSH compared to contract value (0.1% - 5%). However, this difference does not significantly affect the results of their benefit-cost ratio. From the BCR that has been obtained from 6 companies, there were four companies with a score greater than 1 which show that the OSH program is acceptable and has higher benefit from the perspective of economical compared to the cost. There is one company that has a BCR close to 1 (0.93) and it is considered that the program is acceptable even if the BCR is less than 1. This might happen due to lack of duration on implementing the OSH program (less than 1 year), and the BCR might increase after a long period of implementation. Among 6 companies, there is one company whose BCR is less than 1 (0.47) which indicates that the program is less effective and needs further improvement. There are several possibilities that can cause the low BCR on this company's OSH program, such as low investment value on OSH program (0.1% from the project value) or missed estimation on the benefit value. There is also another company that has extreme BCR (6.09), this showed that the OSH program is highly cost effective. This high BCR may be due to excellent innovation on reducing the cost of the implementation.

Interestingly, the highest BCR occurred at a small company (ID1) with a supervision OSH program. This shows that a supervision program can be highly effective in increasing the safety awareness and culture within the company. However, it is worth noting that ID1 has a relatively small number of manpowers. Supervising a large number of manpowers can be challenging. Thus, we suggest that supervision program is implemented by small companies.

Lao PDR. The construction industry is an important sector that grows rapidly in Lao PDR. Globally, the sector typically ranks first with regard to the number of occupational incidents and deaths – it is safe to say that the construction sector in Lao PDR is no exception. A construction project often has numerous workplace hazards, some of which are of high risk that could lead to serious injuries, illnesses or even fatal incidents. Therefore, it should receive more attention with respect to improvement of workplace safety and health. Implementing OSH for this sector has been challenging, typically due to the perception that there are additional costs to project rather than viewing it as an investment that would give a return in terms of benefits obtained. It is indeed not easy to quantify some of the benefits of OSH programs in financial terms, especially those that are indirect or intangible, such as all the avoided troubles associated with an incident, potential improvement in productivity and personnel's morale, or company's improved reputation, etc. This study plays an important part in demonstrating that the OSH program is in fact economically and socially beneficial for the construction sector with a data- driven approach.

Lao PDR has submitted 1 small company and 5 medium companies. Unfortunately, large companies could not be represented in this project. The BCR from these 6 companies range from 0.7 to 2.4, with four companies scored greater than 1 which show that the OSH program is acceptable and has higher benefit from the perspective of economical compared to the cost. On the other hand, there are two companies whose BCR is less than 1 (0.71 and 0.85) which indicates that the program is less effective and needs further improvement.

Based on the industry classification, the mining construction industry has the lowest BCR among the others (0.71), with the largest %OSH investment. Surprisingly, the OSH program held by this company was an OSH campaign. In other AMS, campaign programs have resulted in better BCR. The best type of OSH program with the criteria of the best BCR score in Lao PDR was the training program (average: 1.77).

Malaysia. This study is very important to ensure that every OSH program is 'value for money'. It is also an important tool to measure if the OSH program has achieved its objectives. This study also highlighted the ratio of costs spent for OSH to the overall cost of the project. The OSH programs included in this analysis are selected because the contractors have data on cost spent for the OSH programs and their perceived benefits. There are other OSH programs carried

out by contractors in their construction sites but not included in this study, which may also contribute to the overall effective safety and health management.

Different categories of contractors invested different costs for OSH. Large projects (MY3, MY6, MY7 and MY8) spend more than medium (MY2, MY4 and MY5) and small projects (MY1). However, the ratio analysis (as in Table 5) shows that, in proportion to the project contract value, medium and small projects are spending more on OSH programs than large projects. One of the ratios for medium project (MY4) is lower than the small project (MY1). The result of this study is not consistent with Ikpe et al. (2012), who reported the ratio for small projects is higher than both the medium and large projects. The benefit- cost ratio (BCR) reveals that the benefit is greater than the cost for all OSH programs. Large projects (MY3, MY6 and MY8, with exception for MY7) recorded the highest ratio, then medium (MY2, MY4 and MY5) and small (MY1) projects. This makes a good business case for encouraging projects to carry out preventive OSH programs because these initiatives would result in benefits that are measurable. The average ratio for all projects is 2.43:1, which can be used to estimate the accident prevention cost. This is slightly lower than Ikpe et al. (2012) who reported a ratio of 3:1 in the United Kingdom.

Malaysia has submitted 7 data from oil and gas construction companies (both medium and large), and 1 data from a small public facility construction company. Among the 7 data, although each one of them have generated satisfactory results, large oil and gas companies have the highest average of BCR (4.12) with the lowest average %OSH investments. The type of OSH programs that had resulted in the highest average of BCR were supervision and campaigns.

Myanmar. Unlike its ASEAN counterparts, Myanmar has not experienced substantial growth in it construction sector, particularly due to recent economic and political crisis (ILO, 2021). Occupational safety is still a pressing issue; only a few companies have already started to implementing ISO 9001 Standards. The new Occupational Safety and Health (OSH) Law in March 2019 is expected to pave the way for the first legally established health and safety standards in the country (Chau, 2019). Meanwhile, most workplaces in Myanmar are still operating below international health and safety standards and construction incidents are common and widely reported. Statistics on workplace health and safety problems are not readily accessible, although occupational health and safety problems have been acknowledged by the various government stake holders (such as the Ministry of Labor or Ministry of Construction). Construction projects can be typically divided into building or infrastructure. The Ministry of Construction often becomes a single entity that conduct planning, execute the construction activities, while being a customer at the same time. Budgeting with respect to OSH program is often lacking (ILO, 2021). Most of the construction companies employ about less than 100 to more than 7,000 workers, with managers often recruited having international experiences. OSH training could be of interest, but it is not supported by the current laws regulating occupational safety. Contracts are often not explicitly stated, resulting in sub- contractors not following OSH practices.

Such unique condition may necessitate the "productivity and efficiency" criterion in introducing economic justifications of their OSH programs. Projects that are funded by bilateral or multilateral agencies generallyrequire pre-feasibility check, which could cover close monitoring of safety and environmental aspects of the projects. Such requirements can also be a driving factor in justifying OSH programs in the workplace.

The Philippines. Data gathering for this project was facilitated by the Occupational Safety and Health Center through its connection with Philippine Contractors Accreditation Board (PCAB). The requirement for financial and safety data made it difficult for many companies to participate readily without the express approval of top management. The companies had to be assured that they will remain anonymous because the data they share may be used against them in the end. Most of the benefit-cost ratio computed are a little higher than 1. This is especially true for large construction companies that have higher investment in OSH. It is also possible that these companies were not able to put a reasonable estimate to potential for new business and a good corporate image. Large companies have a lot of goodwill, and they might think that the brand image is helping them to win clients and not their safety record. These companies will only know the benefit of safety if they lose clients because of it. The findings of the study can be used as benchmarks by other construction companies in the Philippines in allocating budget for OSH and gathering and monitoring safety data. Construction companies will get a realistic estimate on the percentage of cost associated to OSH and can put it in the budget. Data on accidents and incidents can also be used as standard key performance indicators in the construction industry.

The Philippines has an average BCR of 2.26 where two out of six companies from the Philippines have the value of BCR lower than one. This implies that two companies from the Philippines suffer losses from implementing OSH program, meanwhile the other four gain benefit. However, we cannot see the data as is because of the lack of information about benefits gain by the company from implementing the program. The incapability of company noticing the benefit and quantify it can result in understatement of calculated BCR. With the data we have, we can conclude that majority of companies in the Philippines gain benefit from implementing OSH program. These findings could lead other companies seeing the benefits of implementing OSH program, thus could result in better safety awareness and culture in project.

Singapore. Numerous studies have been conducted around the world to investigate the importance of occupational health and safety, their related costs as well as the financial consequences of accidents in the workplace. Accidents in the construction industry have been found to impose substantial costs not just to workers but to employers and society too (Haslam et al., 2004). A study by the Singapore Workplace Safety and Health Institute, published in 2013, estimated the economic cost of work-related injuries and ill-health in Singapore to be S$10.45B for the year 2011, equivalent to 3.2% GDP. This amount can be further

broken down as cost borne by workers (S$5.28B), by employers (S$2.31B) and by community (S$2.87B).

For this study, the average BCR was 0.84, while the lowest BCR was 0.48. The latter figure corresponded to 1.19% OSH investment (relative to the contract value). There was a tendency that a greater BCR was associated with a greater OSH investment. For example, the greatest BCR (1.38) was obtained from an OSH investment of 3.1%. However, this analysis was only applicable to large- and medium-sized companies. No data were available pertaining to the benefit and cost of OSH program that were obtained from small-sized companies; thus, further study was needed from small-sized companies in order to get more solid information.

Thailand. Cost-benefit analysis is an important tool that the enterprises will be able to use to help them make the right decision in order to invest the OSH program in the construction site. The advantages of cost-benefit analysis make the enterprises not only understand implementation cost including procurement, installation, training, operation, maintenance, program promotion and other expense but also predict the costs saved and potential benefit resulting from the OSH program. Which leads them to clearly see the correlation between cost and benefit and then make decisions in a structured manner. This research collected the cost-benefit of safety and health programs from 6 enterprises consisting of 2 small-size, 2 medium-size and 2 large-size enterprises. It can be seen that a total of benefits are higher than a total of costs in Small Enterprise 1 (S1), Small Enterprise 2 (S2) and Large Enterprise 2 (L2). However, a total of benefits are less than a total of costs in Medium Enterprise 1 (M1), Medium Enterprise 2 (M2) and Large Enterprise 1 (L1).

Thailand has an average BCR of 2.07. This number implies that the overall implementation of OSH program in companies across Thailand gave more benefits than the costincurred. The average of BCR in variety of company sizes also gives BCR greater than one and could strengthen the previous argument. Thailand could get average BCR greater than one because Thailand has the capability to identify and quantify the benefit received from implementing OSH program.

Viet Nam. This study was the first of its kind conducted, perhaps in Viet Nam. This study is very important to ensure that every OSH program is “value for money”. It is also important tool to measure the OSH program has achieved its objectives. This study also highlighted the ratio of costs spend for OSH to the overall cost of the project. The OSH programs included in this analysis are selected few that the contractors have data on cost spent for the OSH programs and their perceived benefits. There are other OSH programs carried out by contractors in their construction sites but not included in this study, which may also contribute to the overall effective safety and health management. These findings on economic justification on implementing OSH program is very useful and hopefully it can

eliminate the stigma on implementing OSH that will certainly very useful for construction enterprises around the world, especially for Viet Nam. Findings from this study suggest that keeping a safe workplace has significant financial benefits. On the bigger scope, the result can also be used not only as a basis for an extensive study, but also as a basis for creating national or regional policy on implementing OSH at construction sector.

Viet Nam has an average BCR of 4.18. The average of BCR across various company sizes also gives BCR greater than one. This may happen because small and medium-sized companies in Viet Nam have an average % amount invested on OSH relative to project contract value at more than 1%. The average % amount invested on OSH in Viet Nam is bigger than some of any other companies across AMS. This implies that Viet Nam has bigger commitments in safety than any other AMS in economic terms. However, we cannot overlook the fact that safety commitments are beyond benefit and cost.

4.3. Additional Findings

Findings from this collaborative research effort demonstrated that the average of BCR across AMS was roughly 2.3, implying that the benefits obtained from an OSH program clearly outweighed the costs of the program. This ratio means that any OSH program implemented in the workplace will result in benefits that are at least twice greater (from the economic perspective) than the investment spent. It should be noted however, that the BCR values ranged from about 0 to greater than 11.0 (both were respondents from the Philippines). The former basically means that nearly no benefits can be obtained from an OSH program, whereas the latter implies that the benefits (tangible and intangible) are much greater than the money invested in the program.

There was a tendency that larger enterprises were associated with markedly greater BCRs. However, no significant BCR difference was found between small and medium size companies. Comparisons among small vs. medium vs. larger contractors have been discussed by Ikpe et al. (2011). In contrast to findings in this study, their work demonstrates that small and medium contractors tend to gain greater benefits in proportion to their turnovers compared to larger companies.

While a BCR of close to zero is not uncommon, it is possible in this study that the company and the national expert were not able to investigate the actual benefit resulting from their OSH program. Had they been able to investigate the positive effects more carefully, they would have obtained more quantifiable benefits. A carefully designed OSH program should yield a BCR substantially greater than zero, preferably greater than one. Note that all aspects of the costs and benefits should be quantified in monetary terms, and this should be done with great care. Otherwise, some of the costs will be hidden and the actual expense cannot be calculated correctly.

Similarly, all positive effects resulting from an OSH program should be quantified adequately. The effects should include all costs avoided (e.g., hospitalization, litigation, etc.) and benefits gained (e.g., improved productivity or quality). These effects, while sometimes difficult to monetize, should be quantified appropriately. In addition, some benefits can be intangible (such as company image). This kind of benefit could be very difficult to monetize, but previous experience and research from the literature can be used as a basis in determining the correct economic values. Findings from this research clearly demonstrated that a carefully designed OSH program, followed by cautious analysis of its costs and all potential positive effects, will likely result in positive net present values (i.e. BCR greater than one). Results from this study can be used as a motivating case or evidence that an OSH program can actually provide valuable impact for the construction industry. Of course, a company cannot deliberately design any OSH program without careful analysis to its costs. What the findings here demonstrate is that an OSH program does not necessarily imply an economic burden to a company. If done correctly and analyzed adequately, a variety of OSH programs can actually be designed and provide long-term competitive advantages.

5. Discussion and Conclusions

5.1. Challenges

This study found that there are a number of challenges that needed to be addressed in order to successfully implement the economic analysis of an OSH program in the construction sector. At the ASEAN-OSHNET regional level, the common issues are the ability: 1) to completely identify and to collect the actual expenses and benefits data resulting from the program (this also means having the required access to the data), 2) to convert the benefits gained into the exact monetary values, and 3) to carefully employ benefit-cost analysis in justifying the implementation of an OSH program. It should be noted, however, that data availability could differ among AMS. Data availability could also be influenced by the company size and whether the company is private or government owned. Larger companies in more developed AMS may have better database and workplace safety and health (reporting) system, that makes the economic analysis easier to conduct.

Further analysis of benefits that can be reaped is probably much more difficult since some of the benefits can be probabilistic or intangible in nature (e.g., company image or costumer trust). Many other tangible benefits are also difficult to monetize, since it involves data that the company does not have (such as reduced likelihood of slip, trip, and fall). Therefore, it is suggested here that a construction company set up a data base consisting of previous OSH programs (and the respective investments). The data base should also track the resulting injury/ill health effects data, as well as other data pertaining to project/business performance indicator. Currently there is no standardized sets of best practices for the construction sector, but a number of recommendations could be followed among AMS. These include posting incident data along with the costs for the employees to see. Such data can improve learning experience and awareness among workers and, when managed in a record keeping system, will also help companies perform more detailed benefit-cost analysis in the future. Train managements, supervisors, and employees on occupational hazards and ways to control them. Education is believed to be the first approach to be taken to significantly improve workplace safety and health in the workplace (Goetsch, 2014). Substantial improvement of working conditions can also be obtained via understanding overall company strategy. A classic approach of balanced scorecard (see for example Kaplan & Norton, 2006) could be one of the best approaches in aligning safety and health performance with the goals of the organization. Lastly, get buy-in from employees buy adopting behavior-based safety (Velmosky, 2019) or similar approach. This can work well in construction companies with employees having different cultural, social, or economical backgrounds. Lastly, the benefit-cost evaluation has been shown to be a compelling technique in ensuring management on the importance and justification of implementing an OSH program. This technique can also be used in designing, formulating, and

selecting the most optimal OSH programs. Such a technique is beneficial in predicting if an OSH program will indeed provide benefits.

It should be noted here that safety and health programs should not be evaluated from merely cost perspectives. A safe working environment is indeed the right that should be provided to the workers (Elvik, 2003). When carefully designed, OSH initiatives can actually foster productivity and profit (Oxenburgh et al., 2004). Instead of relying solely on safety technologies and procedures, improving safety and health through active worker involvements should be viewed as a management strategy in improving company's business bottom line. This is not to mention that occupational injury and ill health can detrimentally affect the society and government priorities.

5.2. Conclusions

Workplace incidents/fatalities and ill-health problems have generally plagued the construction sector, a serious issue faced by both developing and industrialized nations. Despite the potential advantages, OSH programs in the construction industry have often been viewed as an economic burden. Large companies usually comply to national and government regulations. However, this may not apply to much smaller construction enterprises. Thus, an OSH program is usually implemented only at the minimum level as required by national laws and regulations. A different mindset is offered here in this study, in that a carefully designed OSH program can in fact provide positive effects (in terms of costs avoided and business benefits) that outweighs the investments spent for the program. NPV calculations that translate into BCR can be employed as a methodology in determining if an OSH program is worth investing.

It is concluded from this study that economic rationale (BCR and NPV analysis) can actually be employed to justify an OSH program in the construction industry. An average BCR of 2.3 was determined across the eight AMS participating in this collaborative project.

Note that greater OSH investment does not necessarily result in greater BCR values; a greater BCR merely means that the program has much more benefits than the expenses. A careful analysis should meticulously identify literally all costs spent for an OSH program. Likewise, the analysis should consider all advantages resulting from the implementation of the program. The analysis should recognize all costs that can be avoided due to the the existence of the program and should also identify all potential (tangible and intangible) benefits associated with the program. Although converting these benefits into monetary values can be somewhat difficult and challenging, such analysis should still be conducted. A methodological framework has been offered in this study that allows for monetizing all potential benefits. In summary, this collaborative study provided evidence that careful economic analysis indeed resulted in justified OSH programs, and the corresponding methodologies could be used as a viable

approach in justifying expenses associated with expensive OSH investments. Through careful economic evaluation, managers and project owners should not be hesitant in designing and providing much safer and healthier workplaces, even though the resulting OSH programs could initially be seen as an economic burden to the company. Safe and healthy workers should be used as a competitive advantage that will lead to more productive work and, eventually, more sustained businesses in this competitive era.

5.3. Recommendations

While the same methodology can be employed across AMS, the nature of the industry could be different across nations leading to differences in the focus of the OSH programs. For instance, OSH programs that merely enforce workers to follow good safety practices may not be a priority in Singapore due to company's stronger adherence to national laws and regulations. Construction companies in Singapore may not necessarily evaluate their OSH programs aimed at meeting national regulations from an economic point of view. Rather, they may probably use the economic analysis when selecting different technologies in improving workplace safety and health. In contrast, focus of OSH programs for Indonesia and Malaysia could be directed more toward the educational and engineering (work design) aspects of the 3 E's in improving workplace safety.

The construction sector in Brunei Darussalam may be characterized by fairly low fatality rate, but the prevalence of migrant workers with different cultural background may characterize workplace safety and health issues. Due to relatively slower growth in construction in Viet Nam, the interest of construction companies there is probably more toward obtaining more projects and contracts. Efficient operations with the least amount of resources (expenses) are probably the way to remain competitive. Safe and healthy workplaces, therefore, may not rank first in this context. This study showed that all AMS can utilize benefit-cost analysis in evaluating an OSH program in the construction industry. This analysis can also be used in determining which types of OSH programs to implement, considering the unique characteristics of the construction sector of each AMS.

Note that a study by Meswani (2008) demonstrated challenges in implementing an OSH program, which include cultural issue, leadership mindset, and corporate commitment. Construction companies in different AMS could also be characterized with different safety management system, levels of worker education, training, and safety awareness, as well as different types of technology used in the industry. The point is that each AMS may have unique national culture and characteristics that can influence how an OSH program in the construction industry can be suitably and effectively designed and implemented. Thus, construction companies in each AMS could have slightly different approaches from one another in utilizing the methodology.

This study finally highlights the importance of having a satisfactory database consisting of all expenses associated with an OSH program. These expenses have to be calculated, prorated, and discounted carefully according to the time horizon being evaluated. The database should also consist of all costs saved and benefits potentially gained from implementing an OSH program. Such a program may also result in intangible benefits (company image, customer trust, etc.) or benefits that are difficult to quantify (such as improved product quality). Despite this difficulty, all potential tangible as well as intangible benefits should still be identified, quantified, and monetized. Company historical data and those from the literature could be used as a basis for this procedure. Only by carefully examining all these costs and benefits can a company make a decision with regard to the feasibility of implementing an OSH program.

Findings of this study, however, clearly demonstrated that a carefully designed OSH program will usually yield results that are acceptable from an economic point of view. It is noteworthy that, although OSH programs can be designed in a variety of ways, certain programs can actually result in greater effectiveness. Ikpe et al. (2011) suggests that construction companies focus more on accident prevention than to design programs that minimizes the severity of a workplace accident. Furthermore, investments on knowledge, awareness, and monitoring are more preferable than spending on after-the-fact measures (such as first aid). The benefits can be long-lasting and tends to be ultimately more efficient. This should convince and persuade managers and project owners in providing their workers a safe, healthy, and productive workplace.

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Appendix 1: Questionnaire

Research tool on Economic Justification of Occupational Safety and Health (OSH) Implementation in the Construction Sector

Occupational Safety and Health Program Questionnaire for the Construction Industry

Dear Sir or Madam:

The purpose of this questionnaire is to gain information on economic justifications for OSH implementation in the construction sector. This questionnaire is used to identify all costs/investments associated with implementing OSH programs and to identify all potential benefits (e.g., costs saved/avoided) resulting from such programs. This instrument consists of three (3) parts. To assist you in filling this questionnaire, please read the Questionnaire Guide attached with this document. Please respond to all the questions in this survey.

Your identity (and your company's name) will be kept confidential and your cooperation is highly appreciated. Thank you.

For inquiries about this survey, please contact:

Glossary

An **accident** is regarded as a particular incident in which an injury, illness, or fatality occurs.

An **incident** is a work-related event(s) in which an injury, ill-health (regardless of severity), or fatality occurred, or could have occurred.

A near miss is an incident that **did not** result in a fatality, injury, illness, or damage – but had the potential to do so.

First Aid is the help given to a sick or injured person until full medical treatment is available.

Man-hour is an hour regarded in terms of the amount of work that can be done by one average person within this period.

Project working days is the number of calendar days of work for the project regardless of the number of workers.

LTIFR (Lost Time Injury Frequency Rate) is the number of lost-time injuries/LTI occurring in a workplace per 1 million man-hours.

LTIFR (Lost Time Injury Frequency Rate) is the number of lost-time injuries/LTI occurring in a workplace per 1 million man-hours.

Part I. Project Data

Choose one project in your company and answer all of the following questions according to that project.

Project name :

Which industry is this project classified in? :

(Example: Manufacturing, commercial, institutional, recreation, retail, housing, public facility project)

Project contract value ($) :

Project duration (years, months) :

Project assignor :

Source of funds :

No	Question	Response
1	What is the number of working days in this project?	
2	What is the typical number of the workforce (including contractors)?	
3	What is the total amount invested by the company for OSH programs for this project (US$)?	
4	What is the number of near-miss per 1 million man-hours?	
5	What is the number of first aid per 1 million man-hours?	
6	What is the number of incidents resulting in damaged equipment/property (more than US$100) per 1 million man-hours?	
7	What is the number of incidents per 1 million man-hours?	
8	What is the number of injured workers per 1 million man-hours?	
9	What is the number of fatalities per 1 million man- hours?	
10	What is the LTIFR (*Lost Time Injury Frequency Rate*)?	

11	How many working days were lost due to incidents?		
12	How much has been spent on compensation due to accidents (US$)?		
13	What is the number of safety audits for the project?		
14	What is the number of safety training for the project?		
15	Investment in safety and health personnel:		
	15.1 *On-site*:		
	Position	Amount	Monthly Wage (US$)
	Safety officer		
	Safety supervisor		
	Secretary/administration		
	Others: _____		
	15.2 Main Office		
	Position	Amount	Monthly wage (US$)
	Safety manager		
	Chief safety officer		
	Senior safety officer		
	Secretary/administration		
	Others: _____		

State the name of occupational safety and health programs that has been implemented in the project:

1.

2.

3.

Part II – Occupational Safety and Health (OSH) Program

State the name of one OSH program that has been implemented in the project:

_____

OSH program description (location, stakeholder, and others):

Write down all the effects of the implementation of the OSH program:

Example: If the program did not exist, it is estimated that the number of workers in an accident is _____ people.
1.
2.
3.
4.
5.

List the relevant OSH program implementation costs using the table below.

No	Program implementation costs description	Description and calculation	Costs (US$)	Payment Period (example: monthly, semesterly, beginning of the project, the end of the project)
1	Procurement (purchased tools, machines)			
2	Installation			
3	Training			
4	Operation			
5	Maintenance			
6	Program promotion			
7	Project Health and Safety Management Plan preparation			
8	OSH promotion			
9	Insurance			
10	OSH personnel			

No	Program implementation costs description	Description and calculation	Costs (US$)	Payment Period (example: monthly, semesterly, beginning of the project, the end of the project)
11	Health facility			
12	Safety signs			
13	Other costs regarding OSH risk management			
14	Other costs:			

List of costs avoided/saved resulting from the OSH program (please add more costs to the list and write the actual amount in US$)

Costs avoided description		Description and calculation	The estimated total cost saved (US$)	Paid by:
Medical	First aid			☐ Company ☐ Insurance ☐ Workers/ Family
	Administration			☐ Company ☐ Insurance ☐ Workers/ Family
	Hospitalization			☐ Company ☐ Insurance ☐ Workers/ Family
	Medical personnel			☐ Company ☐ Insurance ☐ Workers/ Family
	Medical costs			☐ Company ☐ Insurance ☐ Workers/ Family
	Rehabilitation			☐ Company ☐ Insurance ☐ Workers/ Family
	Compensation			☐ Company ☐ Insurance ☐ Workers/ Family
	Insurance costs			☐ Company ☐ Insurance ☐ Workers/ Family
	Accident investigation			☐ Company ☐ Insurance ☐ Workers/ Family

Costs avoided description		Description and calculation	The estimated total cost saved (US$)	Paid by:
Equipment and property	Equipment damaged/ replacement cost			☐ Company ☐ Insurance ☐ Workers/ Family
	Repairing cost			☐ Company ☐ Insurance ☐ Workers/ Family
Time	Loss time of the injured worker			☐ Company ☐ Insurance ☐ Workers/ Family
	Loss time of coworker to take care of the injured worker			☐ Company ☐ Insurance ☐ Workers/ Family
	Loss of time because of project stopped temporarily			☐ Company ☐ Insurance ☐ Workers/ Family
	Overtime costs			☐ Company ☐ Insurance ☐ Workers/ Family
Temporary Staff	Recruitment			☐ Company ☐ Insurance ☐ Workers/ Family
	Training			☐ Company ☐ Insurance ☐ Workers/ Family

Costs avoided description		Description and calculation	The estimated total cost saved (US$)	Paid by:
Others				☐ Company ☐ Insurance ☐ Workers/ Family
				☐ Company ☐ Insurance ☐ Workers/ Family
				☐ Company ☐ Insurance ☐ Workers/ Family
				☐ Company ☐ Insurance ☐ Workers/ Family

Appendix 2: National Report

National Report

RESEARCH ON ECONOMIC JUSTIFICATION OF OCCUPATIONAL SAFETY AND HEALTH (OSH) IMPLEMENTATION IN THE CONSTRUCTION SECTOR

CAMBODIA

I. Introduction

The construction industry in Cambodia is dramatically increasing in these last decades. Based on the Ministry of Land Management, Urban Planning, and Construction report in December 2021, **from 2000 until December 2021; there were 2392 buildings of 5 floors up building construction, 1324 buildings of 5-9 floors building construction, 675 buildings of 10-19 floors building construction, 220 buildings of 20-29 floors building construction, 123 buildings of 30-39 floors building construction, 50 buildings of 40 floors up building construction, and 474 projects of housing borey construction.** The growth rate of construction is rapidly increasing, the construction standards and site safety have become the most concern. Currently, The Ministry of Land Management and Urban Planning and Construction has been enacted and promulgated the new construction law to regulate the construction industry in Cambodia.

According to the Ministry of Land Management, Urban Planning, and Construction report, the ministry has issued a certificate of license for **3172 companies** for the construction sector.

The occupational accident is also significantly increasing with the growth of construction in the country. In 2009, the International Labour Organization (ILO) estimates that more than 1,500 workers are killed each year by occupational accidents in Cambodia. Most of these accidents occur in construction sites, brick kilns and small enterprises that have neither the knowledge nor system in place to protect workers. Common causes of injuries, illnesses, and death include falls from heights, being struck by falling objects, the collapse of buildings or structures, electrocution, suffocation, and exposure to hazardous chemicals such as asbestos.

Due to the enormous growth in the construction industry in Cambodia, the country has faced many challenges, as we struggle to ensure the safety and health of the sector's workforce and workplace. There are several causes, including, the absence of OSH law and regulation for labour inspection in construction sites, weak labour inspection, lack of supply of equipment needed to enforce the standards, scant or no supply of worker insurance, unsatisfactory statistic and reporting system of relevant data on work-related accidents, injuries, and deaths of workers, lack of OSH training and awareness amongst workers and employers, condoned safety standards from employers and sub- contractors, adherence to traditional working methods, lack of technical skills in regards to operating machinery, as well as the absence of any system of skills certification, and general weakness in the formulation and enforcement of the rules within a multi-layer, multi-player construction sector aggravate the situation. However, currently, the Ministry of Labour and Vocational Training is preparing to establish the OSH law, to respond to the issues of safety and health at the workplace in Cambodia.

This research aims aimed at conducting a systematic approach in determining the benefit of occupational safety or health program in the construction sector from

an economic perspective, with data to be collected from all ASEAN Member States. Through this project, it is expected that we will gain knowledge and experience on how economic rationale can be employed to justify the implementation of a safety or health program in the workplace. This understanding can be used further in persuading and motivating the management of national construction companies to carefully evaluate their OSH programs. From this research, each company can also learn how to carefully design OSH programs that will reduce safety and health risks, while satisfying the economic perspective.

II. Results

II.1. Exchange Square construction project

The project was restaurant project, named Exchange Square. The duration of the project was 6 months with 100,000.00 USD of the project contract value. The working day of the project was 6 days per week, a total of 144 working days. There were 39 workers who worked on-site. Among those 39 workers, 10 workers were sub-contractor. During the project, there were some work accidents that occurred in the project. As the result, the number of work-related incidents per 1 million man-hours is 25.9875 and, the number of injuries per 1 million man-hours is 25.9875.

This project has invested on OSH in the project is approximately 3311$USD. They have 6 safety training for their employees and 2 safety audits for the project. The project also employed the safety and health personnel on-site and Main Office. On-site, the company has appointed a safety officer with a monthly wage of 430(USD), a safety supervisor with a monthly wage of 650(USD), a secretary/administration with a monthly wage of 300(USD), and a warehouse store with a monthly wage of 280(USD). At Main Office, there was a safety manager with a monthly wage of 770(USD), a Chief safety officer with a monthly wage of 1100(USD), a senior safety officer with a monthly wage of 900(USD), an administration with a monthly wage of 300(USD), a document control officer with a monthly wage of 700(USD).

This project has been implemented three OSH programs, such as; (1) Inflammation of the airways by smoke (Ex: Welding fire system...), (2) Manual handling, Working at height, Fire prevention or Fire protection, (3) Smoking Drugs, Drinking Alcohols and COVID-19 prevention.

Benefit-cost Ratio of the Exchange Square Construction on OSH program is 1.24

II.2. Tribe Hotel Construction project

This project is classified in commercial industry, as it is plan to be a hotel, named Tribe Hotel. The duration of the construction was 27 months with 16million

USD of the project contract value. The working day of the project was 6 days per week, a total of 702 working days. There were 200 workers who worked on-site, including 50 sub-contractor. The number of of work-related incidents per 1 million man-hours is 5.22 and, the number of injuries per 1 million man-hours is 4.35.

This project has invested on OSH in the project is approximately 48,080$USD. There were 220 Safety Tool box meeting, 80 Safety inductions, and 4 safety audits for the project. The company has appointed the safety and health personnel on-site. On-site, the company has appointed 3 safety officers with monthly wage of 550(USD), a safety supervisor with a monthly wage of 750(USD), 2 secretaries /administrations with monthly wage of 400(USD).

This project has been implemented three OSH programs, such as; (1 Safety Tool box (2) Safety Induction 3) COVID-19 prevention.

Benefit-cost Ratio of the Trible Hotel Construction on OSH program is 1.79

II.3. ECCC'S Construction project

The project was classified in public facility industry, as it is the building of Legal Documentation Center of the Extraordinary Chamber in Courts of Cambodia and Bar Association Office in Cambodia. The duration of the construction was 18 months with 1.9 million USD of the project contract value. The working day of the project was 6 days per week, a total of 468 working days. There were 95 workers who worked on-site. The number of work-related incidents per 1 million man-hours is 89.03 and, the number of injuries per 1 million man-hours is 89.03.

This project has invested on OSH in the project is approximately 59,400$USD. They have 9 safety training for their employees and 2 safety audits for the project. The project also employed the safety and health personnel on-site and Main Office. On-site, the company has appointed a safety officer with a monthly wage of 500(USD), a safety supervisor with a monthly wage of 700(USD), a secretary/administration with a monthly wage of 400(USD), and a warehouse store with a monthly wage of 300(USD). At Main Office, there was a safety manager with a monthly wage of 770(USD), a Chief safety officer with a monthly wage of 1200(USD), a senior safety officer with a monthly wage of 1000(USD), an administration with a monthly wage of 700(USD), a document control officer with a monthly wage of 300(USD).

This project has been implemented three OSH programs, such as; (1) Inflammation, Working at height section, manual handling (2) Fine System, Smoke in welding works (3) Electrical System.

Benefit-cost Ratio of the ECCC's Construction on OSH program is 1.42

II.4. MUD-PPCC construction project

The project was classified in commercial industry. The duration of the construction was 3 years 8 months with 105 millions USD of the project contract value. There were 118 workers who worked on-site. The number of work-related incidents per 1 million man-hours is 1.37 and, the number of injuries per 1 million man-hours is 11.5.

This project has invested on OSH in the project is approximately 2millions USD. They have 140 safety training for their employees and 4 safety audits for the project. The project also employed the safety and health personnel on-site and Main Office. On-site, the company has appointed 2 safety officers with monthly wage of 1000(USD), a safety supervisor with a monthly wage of 1200(USD), a secretary/administration with a monthly wage of 800(USD).

This project has been implemented three OSH programs, such as; (1) MUD-PPCC [2020] No. 3 Notice on Issuing the 2020 Work Plans and Measures for Safe Production and Three Businesses of the Phnom Penh City Center Complex Project in Cambodia, (2) MUD-PPCC [2020] No. 25 Notice on Amending the Emergency Rescue Plan and Rescue Disposal Plan for Accidents (Events), (3) MUD- PPCC [2020] No. 4 Notice on Printing and Distributing the "Environmental Protection Implementation Plan".

Benefit-cost Ratio of the MUD-PPCC project on OSH program is 0.13

II.5. GOLDEN SQUARE construction project

The project was classified in commercial industry, named GOLDEN SQUARE. The duration of the construction was 32 months with 22 millions USD of the project contract value. The working day of the project was 6 days per week. There were 200 workers who worked on-site. The number of work-related incidents per 1 million man-hours is 0.24 and, the number of injuries per 1 million man-hours is 0.24.

This project has invested on OSH in the project is approximately 20.000USD. They have 24 safety training for their employees and 6 safety audits for the project. The company has appointed the safety and health personnel on-site and Main Office. On-site, the company has appointed 4 safety officers, a safety supervisor, a secretary/administration. At Main Office, there was a safety manager, a Chief safety officer, 2 senior safety officers, an administration.

This project has been implemented three OSH programs, such as; (1) Site cleaning day (2 Inspect fire extinguisher (3) Toolbox meeting.

Benefit-cost Ratio of the GOLDEN SQUARE construction on OSH program is 5.75

III. Discussion and Conclusion

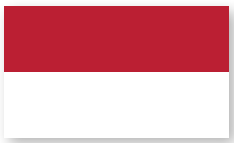
All construction companies that recruited for this research project has completely implemented OSH program. Based on the BCR value obtained from all 5 construction companies, there were one company with extreme BCR value of 5.75 which indicated that this company has perform OSH program comprehensively, cost effectiveness and has produce higher benefit compare to the expend cost. This extreme BCR value might due to the higher value of the investment cost on OSH program. Investment on OSH program will raise awareness and improving caution safety work place. Another three companies, Exchange square, Tribe Hotel, and MUD-PPCC have obtained the BCR value of 1.24,1.79,1.42 respectively. These 3 companies with the BCR value greater than 1 was consider that the OSH program is acceptable with the positive signal. However; there was one construction company that obtained the lowest BCR value of 0.13. This result might due to the lower investment to OSH program (2% from the project value) compare to the duration of the project and project size.

There were several challenges during the data collection process. The first challenge is the recruitment of research subject. As, mentioned above, due to the sudden growth in construction sector, some company are not fit with the requirement of the research. Therefore, we have to find a company with a proper OSH system to do the research. And the second challenge is the time constraint to collect the data. Due to the Covid-19 pandemic, the meeting and gathering is limited which effect on the data collection process. Some company was slow to provide the data, and respond, also some data that provide was incomplete. Last, some company are lack of the data related the estimated cost that can be avoided.

In conclusion, based on the result of Cost-Benefits Analysis, we can see that the majority of the company have implemented OSH program well and effective. However, from this study, we still see that there are many factors that affect the BCR such as duration of implementation, and the differences of total investment value of OSH program implementation in each project. These findings on economic justification on implementing OSH program is very useful and hopefully it can improving the OSH practice in construction sector around the world, especially, Cambodia. This study is also useful for creating the national policy on OSH as well.

National Report

RESEARCH ON ECONOMIC JUSTIFICATION OF OCCUPATIONAL SAFETY AND HEALTH (OSH) IMPLEMENTATION IN THE CONSTRUCTION SECTOR



INDONESIA

I. Introduction

In Indonesia, the construction sector is the third-largest contributor to Indonesia's GDP, and the investments are among the largest out of all construction investments in Asia. The industry has been growing as it is supported by the government's target to develop the archipelago's infrastructure to increase its connectivity. Construction in Indonesia characterised to employ a large number of workers, although it is now commencing to use technology. However, the use of new technology can also be a factor in increasing the risk of accidents as being unfamiliar with the application of new technology.

Aware of the potential high incidents cases that could occur in this sector, the government issued several rules and guidelines on OSH implementation in construction sector. Safety policy has been regulated since long time ago as set in law number 1-year 1970 on employment, Minister of Manpower and Transmigration's regulation number 1-year 1980 on Occupational Safety and Health on Building Construction, Minister of Public Work's regulation number 5/2014 on Guidelines for Occupational Safety and Health Management System for Construction of Public Works, etc. Nevertheless, performance on construction safety seems unsatisfactory as can be seen from many accidents occurred in construction projects until nowadays. (Ghuzdewan & Damanik, 2019).

In 2020, there were approximately 159.3 thousand construction establishments active in Indonesia. Indonesia's construction industry was experiencing increased growth due to increases in infrastructure construction and there were approximately 8.07 million people working in the construction industry in Indonesia. The growth in this sector also followed by numbers of accidents that still happened despite OSH that has been socialized and enforced. The number of accidents in construction is the highest compares to other sector, and another ASEAN country. According to data from the Social Security Administration (BPJS), work accidents in construction increased from 114,000 in 2019 to 177,000 accidents in 2020. Study from Jakarta Manpower Agency has found that most construction projects in the capital are unsafe**.** An inspection conducted by the agency on November 2018 has found that up to 80% of them breached legal standards, with safety and health methodologies non-existent and untrained workers being the norm, in contravention of national regulations. Other challenges that faced by OSH in construction is the cost of implementation, such as the cost of PPE and cost of training on OSH skills and many more, despite the high cost demand, the company or employer are unable to see nor feel the result directly and created stigma that the cost of implementing OSH program are usually much greater than the obtained benefits.

So, through this research projects, justification on cost and benefit from economic perspective of occupational safety or health program can be made. This research project will also gain valuable knowledge and understanding on designing and implementing OSH programs that give benefit for the workers, employer but also cost effective.

II. Results

II.1. Company PT. AK

a. *Background*

PT. AK is an Indonesia-state own company engaged in construction services comprises of Construction of all building's structure sectors, construction of all civil works sectors (such as road construction, bridges, roads and train bridges, harbors, ports, dams, clean water and waste management, stations and others), mechanical and electrical works. PT. AK also engaged on investment on various companies such as companies and/or business management in infrastructure/basic facilities, highway, renewable industry, conversion industry, waste management including Hazardous and Toxic Materials (B3) and others. PT. AK has about 1353 permanent employees and 532 contract employees.

b. *Project Being Studied*

Project being studied on PT. AK is housing project of Revitalization Penjaringan Flats. It is located in Penjarirangan District, West Jakarta, DKI Jakarta Indonesia. The project manager on this project is Mr. Bambang Pamungkas. The OSH program that being studied is "training and education program for workers which is held regularly every week for all workers". The main purpose of the training session is to remind employees to strictly use PPE while working and also trained employees to applied safety work procedures. During the session employees ware provided with healthy food and also invited to do workout. Beside those routine education sessions, HSE also held other training for foreman, assistant foreman, assistant subcontractor, and HSE subcontractors related to extinguishing small fires and riggers. The detail of studied listed below:

- Contract value : US$ 32.003.669,57
- Total OSH investment for the project : US$ 1.600.183,48
- Incidents/1million man-hours : 0.49
- Fatalities/1million man-hours : 0 (no report)
- Injuries/1million man-hours : 0.49

c. Benefit-Cost Ratio for the project

Benefit-Cost Ratio of PT. AK's OSH program that being studied is 1,31.

II.2. Company PT. WK

a. *Background*

PT WK is state own procurement and construction ("EPC") companies established In 1960. PT. WK began as a company engaging in electrical and plumbing installation work, and in the 70s, shifted into becoming a civil and building contractor company. PT. WK have four business segments: Industry, Infrastructure & Building, Energy & Industrial Plant, and Realty &

Property. PT. WK has about 2100 permanent employees and 89 contract employees.

b. *Project Being Studied*

Project being studied on PT. WK is public facility project of "Jakarta-Bandung High Speed Railway.". The project is located East Jakarta & West Java with Mr. Iskandar Purba as project manager. The OSH program that being studied on this project is "Hallo patrol". The purposes of Hallo patrol to remain all employee regarding work safety procedures and share correction procedures on the past safety violation finding. The program is delivered twice a day by all Hallo Patrol PIC which is consist not only HSE personnel but also subcontractors, foreman, workers, and management. The detail of studied listed below:

- Contract value : US$ 1.309.725.758,75
- Total OSH investment for the project : US$ 13.097.257,59
- Incidents/1million man-hours : 0,0272
- Fatalities/1million man-hours : 0 (no report)
- Injuries/1million man-hours : 0,0163

c. Benefit-Cost Ratio for the project

Benefit-Cost Ratio of PT WK's OSH program that being studied is 0,93.

II.3. Company PT. MK

a. *Background*

PT. MK is a private company engaged in construction, interior design, and furniture. The company establish on 2014. PT. MK have been working various construction project such as building, infrastructure, housing, school, etc. PT.MK has about 9 permanent employees and 14 contract employees.

b. *Project Being Studied*

Project being studied on PT. MK is housing project located in Versaeles BSD, South Tangerang, Banten with Mr. Yohans Sangga as project manager. The OSH program that being studied on this project is mandatory PPE use during project. The PPE includes helmet, vest, gloves, boots, welding goggles a long with constant reminder of it on morning briefing. The detail of studied listed below:

- Contract value : US$ 175.559,98
- Total OSH investment for the project : US$ 243,83
- Incidents/1million man-hours : 24,22
- Fatalities/1million man-hours : 0 (no report)
- Injuries/1million man-hours : 24,22

c. Benefit-Cost Ratio for the project

Benefit-Cost Ratio of PT. MK's OSH program that being studied is 0,47.

II.4. Company PT. MA

a. *Background*

PT MA is a private company engaged in the field of general contractors and maintenance services of civil and architectural engineering work, interior, mechanical & electrical installation ant its suppliers, that established in 2002. PT. MA has about 20 permanent employees and 120 contract employees.

b. *Project Being Studied*

Project being studied on PT. MA is institutional project of Building Hall project IC Center at ICM school located Ciater, Tangerang Selatan, Banten. The project was leaded by Mr. Sri Hartono as project manager. The OSH program that being studied on routine OSH education program. The OSH education consist of Work Safety Practice, Wellness and 10 minutes PPE checking that conducted daily. The detail of studied listed below:

- Contract value : US$ 424.964,21
- Total OSH investment for the project : US$ 4.249,64
- Incidents/1million man-hours : 7.34
- Fatalities/1million man-hours : 0 (no report)
- Injuries/1million man-hours : 7.34

c. Benefit-Cost Ratio for the project

Benefit-Cost Ratio of PT MA's OSH program that being studied is 4,21.

II.5. Company PT. SA

a. *Background*

PT SA is a private company engaged in the field of General Contractors, Building Construction, Developers, Property, Electrical and Engineering Installations, and Interior Works. PT.SA has about 7 permanent employees and 13 to 23 contract employees.

b. *Project Being Studied*

Project being studied on PT. SA is a manufacturing project of foundation, pool and roof construction projects for WTP at PT.C, Bekasi, Indonesia. The project lead by Mr. Aziz as project manager. The OSH program that being studied on this project is mandatory PPE use during work as regulated by the user (PT.C). The program consists of wearing helmet and safety boots all the time, and during certain condition they have to wear body harness while work on height, safety goggle while doing grinding, welding shield while doing welding, and buoys while making pool. The detail of studied listed below:

- Contract value : US$ 48.975,38
- Total OSH investment for the project : US$ 504,73
- Incidents/1million man-hours : 0 (no report)
- Fatalities/1million man-hours : 0 (no report)
- Injuries/1million man-hours : 0 (no report)

c. Benefit-Cost Ratio for the project

Benefit-Cost Ratio of PT SA's OSH program that being studied is 1,69.

II.6. Company PT. IK

a. Background

PT IK is a private company engaged in the field of general trading, contractors, manufacturing, and services that established in 2016. PT. IK has about 30 permanent employees.

b. Project Being Studied

Project being studied on PT. IK is an office building maintenance project at PT. A which is located in Sunter Jaya, Tanjung Priok, Jakarta Utara, DKI Jakarta. The leader of this project is Mr. Hadi. The OSH program that being studied on this project is "Certified WAH (Work at Height) supervising on non-certified workers". The supervising including scaffolding installation, locking system, safety procedure during climbing descending, and working activity at height. The detail of studied listed below:

- Contract value : US$ 17.462,37
- Total OSH investment for the project : US$ 873,12
- Incidents/1million man-hours : 0 (no report)
- Fatalities/1million man-hours : 0 (no report)
- Injuries/1million man-hours : 0 (no report)

c. Benefit-Cost Ratio for the project

Benefit-Cost Ratio of PT IK's OSH program that being studied is 6,09.

III. Discussion and Conclusion

In general, the construction companies that being studied has implemented OSH program with various quality and quantity. This can be seen from the difference of investment value of implementing OSH compares to contract value (0.1% - 5%). However, this difference does not significantly affect the results of their benefit-cost ratio. From the BCR that have been obtained from 6 companies, there were 4 companies with a score greater than 1 which show that the OSH program is acceptable and has higher benefit on perspective of economical compare to the cost. There is one company that has BCR close to 1 (0.93) and it is considered that the program is acceptable even if the BCR is less than 1. This might happen due to lack of duration on implementing OSH program (less than 1 year), and the BCR might increase after long period of implementation. Among 6 companies, there is one company that the BCR is less than 1 (0.47) which indicates that the program is less effective and need further improvement. There are several possibilities that can cause the low BCR on this company's OSH program, such as low investment value on OSH program (0.1% from the project value) or missed estimation on the benefit value. There is also another company that has extreme BCR (6.09), this showed that the OSH program is highly cost effective. This high BCR may be due to high

investment value on OSH program (5% from the project value) or may be due to excellent innovation on reducing the cost of the implementation.

During the data collection process, there were several obstacles. The first obstacle is related to the recruitment of research subjects. This happened because the conditions at the time of recruitment were nearing the end of the year so the company was busy preparing year-end reports. Second, the time constraint to collect data because of the conditions at the time of data collection when restrictions on community activities was relaxed regarding the Covid-19 pandemic and the company was busy carrying out activities that were not appropriate when restrictions on community activities was tight and the company was slow to respond, slow to provide data and the data provided was lacking or incomplete. Third, it is difficult to fill in data related to the estimated costs that can be avoided due to the lack of data from the company.

In conclusion, from all of the result of Cost-Benefit Analysis we can see that majority, the subjected companies for this study have implemented OSH program quite well and effective in terms of financing by looking at the BCR value of the profits obtained compared to the costs incurred. From this study, we also can see that there are several factors that can affect the BCR such as duration of implementation and investment value of implementing OSH program. These findings on economic justification on implementing OSH program is very useful and hopefully it can eliminate the stigma on implementing OSH that will certainly very useful for construction companies around the world especially Indonesia. On the bigger scope, the result can also be used not only as a basis for an extensive study, but also as a basis for creating national or regional policy on implementing OSH at construction sector.

National Report

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LAO PDR

I. Introduction

The Lao People's Democratic Republic (Lao PDR), although a small economy with a population of about 7 million, has had a strong and steady economic growth at nearly 8 percent for most of the last decade, with the exception of a recent economic downturn due to COVID-19. Lao PDR's GDP reached USD 19.14 billion in 2020, according to the World Bank.

The construction sector is among the largest and fastest growing sectors in the industry in Lao PDR. It contributed about 7.98 percent of the country's GDP in 2019 and 8.61 percent in 2020, according to the Lao Statistics Bureau (LSB). The sector's growth rate was at around 21 percent in 2019 and dropped to about 14.5 percent in 2020, mainly due to COVID-19. In 2020, there were 552 enterprises in the construction sector, with a combined registered capitals of around USD 1.26 billion.[1] As Lao PDR continues to prioritize infrastructure development in order to transform itself from "landlocked" to "land-linked", more investments in the construction sector are expected.

Regarding the workforce in the construction sector in Lao PDR, the most recent data available were based on the Lao PDR Labour Force Survey 2017 by the LSB. The survey indicates that the number of employments in the construction sector was 83,000 or approximately 5.4 percent of the total workforce at that time.

In general, Lao PDR still lacks reporting and database systems for work-related incidents, injuries and occupational illnesses in the workplace, and so there are virtually no reliable statistics available in that regard – let alone any data specifically for the construction sector. In the Statistical Yearbook 2020, the LSB reported 50 victims of occupational accidents in 2019, out of 3,187 enterprises inspected. It is highly likely that the actual number of workplace accidents would be much higher than reported. According to the Labour Force Survey 2017, there were 5,000 cases who received employment injury and occupational disease benefits and 2000 cases received death benefits. While these figures are not indicative of OSH statistics for Lao PDR, they show that numerous accidents, injuries, occupational diseases and even deaths do occur in workplaces across the country.

The objective of this study is to conduct a systematic approach in determining the benefit of occupational safety or health program in the construction sector from economic perspective, with data collected from six companies in Lao PDR. Through this study, it is expected that knowledge and experience is gained on how economic rationale can be employed to justify the implementation of a safety or health program in the workplace. This understanding can be used further in persuading and motivating the management of Lao construction companies in carefully evaluating their OSH programs. It is hoped that the study provides valuable insights on the current state of safety and health, including success factors and challenges faced in the country.

1 Statistical Yearbook 2020, Lao Statistics Bureau, MPI, Vientiane Capital, June 2021

II. Results

II.1. Company 1 – a large-size construction contractor in road/bridge and mining sectors

About the Project	Mining pit construction project
Industry	Mining
Project Contract Value	USD 2,500,000
Project Duration	4 months
Number of Working Days	250 days (working day and night shifts)
Typical Number of Workforce	65 people
Total Project Man-hours	Est. 195,000 man-hours
Total OSH Investment for the Project	USD 70,000
Number of OSH-related Incidents per 1 million man- hours	10.26
Number of Injuries per 1 million man-hours	0
Number of Work-related Illnesses per 1 million man-hours	0
Number of Fatalities per 1 million man-hours	0
Lost Time Injury Frequency Rate (LTIFR)	0

Benefit-Cost Ratio for Company 1's Project: **0.71**

II.2. Company 2 – a small/medium-size building construction contractor (based on the workforce size of the project surveyed)

About the Project	Renovation and construction of public school facilities
Industry	Public facility project
Project Contract Value	USD 2,080,957
Project Duration	18 months
Number of Working Days	468 days
Typical Number of Workforce	85 people
Total Project Man-hours	318,240 man-hours
Total OSH Investment for the Project	USD 18,000
Number of OSH-related Incidents per 1 million man-hours	12.57
Number of Injuries per 1 million man-hours	3.14

Number of Work-related Illnesses per 1 million man-hours	0
Number of Fatalities per 1 million man-hours	0
Lost Time Injury Frequency Rate (LTIFR)	0

Benefit-Cost Ratio for Company 2's Project: **1.36**

II.3. Company 3 – a large-size construction contractor in the hydropower sector

About the Project	Hydropower dam construction project
Industry	Hydropower
Project Contract Value	USD 58,000,000
Project Duration	4 years
Number of Working Days	1460 days
Typical Number of Workforce	115 people
Total Project Man-hours	Est. 1,343,200 man-hours
Total OSH Investment for the Project	USD 210,000
Number of OSH-related Incidents per 1 million man-hours	5.96
Number of Injuries per 1 million man-hours	3.72
Number of Work-related Illnesses per 1 million man-hours	0
Number of Fatalities per 1 million man-hours	0.74
Lost Time Injury Frequency Rate (LTIFR)	1.49

Benefit-Cost Ratio for Company 3's Project: **1.36**

II.4. Company 4 – a small/medium-size building construction contractor

About the Project	Building construction project
Industry	Public Facility Project
Project Contract Value	USD 2,389,400
Project Duration	3 years 1 month
Number of Working Days	1062 days
Typical Number of Workforce	65 people
Total Project Man-hours	Est. 552,240 man-hours
Total OSH Investment for the Project	USD 100,000

Number of OSH-related Incidents per 1 million man-hours	23.54
Number of Injuries per 1 million man-hours	9.05
Number of Work-related Illnesses per 1 million man- hours	0
Number of Fatalities per 1 million man-hours	0
Lost Time Injury Frequency Rate (LTIFR)	1.81

Benefit-Cost Ratio for Company 4's Project: **0.85**

II.5. Company 5 – a medium/large-size power transmission line construction contractor

About the Project	Power transmission line 115kV construction project
Industry	Electricity
Project Contract Value	USD 4,000,000
Project Duration	1 year 6 months
Number of Working Days	540 days
Typical Number of Workforce	150 people
Total Project Man-hours	Est. 648,000 man-hours
Total OSH Investment for the Project	USD 80,000
Number of OSH-related Incidents per 1 million man-hours	30.86
Number of Injuries per 1 million man-hours	15.43
Number of Work-related Illnesses per 1 million man- hours	0
Number of Fatalities per 1 million man-hours	0
Lost Time Injury Frequency Rate (LTIFR)	1.54

Benefit-Cost Ratio for Company 5's Project: **2.01**

II.6. Company 6 – a small/medium-size industrial building construction contractor

About the Project	Factory building construction project
Industry	Manufacturing
Project Contract Value	USD 607,900
Project Duration	5 months

Number of Working Days	140 days
Typical Number of Workforce	35 people
Total Project Man-hours	Est. 39,200 man-hours
Total OSH Investment for the Project	USD 15,000
Number of OSH-related Incidents per 1 million man-hours	76.53
Number of Injuries per 1 million man-hours	25.51
Number of Work-related Illnesses per 1 million man- hours	0
Number of Fatalities per 1 million man-hours	0
Lost Time Injury Frequency Rate (LTIFR)	0

Benefit-Cost Ratio for Company 6's Project: **2.44**

III. Discussion and Conclusion

The construction industry is an important sector that grows rapidly in Lao PDR. Globally, the sector typically ranks first with regard to the number of occupational incidents and deaths – it is saved to say that the construction sector in Lao PDR is no exception. A construction project often has numerous workplace hazards, some of which are of high risk that could lead to serious injuries, illnesses or even fatal incidents. Therefore, it should receive more attention with respect to improvement of workplace safety and health.

Implementing OSH for this sector has been challenging, typically due to the perception that it is additional costs to project rather than viewing it as an investment that would give a return in terms of benefits obtained. It is indeed not easy to quantify some of the benefits of OSH programs in financial terms, especially those that are indirect or intangible, such as all the avoided troubles associated with an incident, potential improvement in productivity and personnel's morale, or company's improved reputation, etc. Needless to say, this study plays an important part in demonstrating that OSH program is in fact economically and socially beneficial for the construction sector with a data-driven approach.

Study challenges:

Based on the national expert's opinion and observation, there were a number of challenges faced during the data collection process for this study from construction companies in Lao PDR, as follows:

- The companies surveyed do not keep OSH-related records or have a structured way of OSH-related reporting or recordkeeping. In the national expert's view,

this would be the case for most local construction companies in Lao PDR. Information on incidents or injuries that occurred in their past project has been obtained based on the project team's memory. This is linked to a larger issue of lacking reporting and database systems for work-related incidents, injuries and occupational illnesses in the workplace, and the reporting requirements have not been widely enforced yet.

- The companies surveyed had difficulties in understanding some of the survey questions, and therefore there were several back-and-forth discussions to clarify and verify the answers given. In particular, the section of the questionnaire that all the companies found most difficult is the costs avoided and potential benefits that would require assumptions. This challenge is further compounded by the translation from English to Lao language, given there are number of technical terminologies.
- A number of companies were reluctant to provide information or participate fully in the survey, even though they had received a letter of request by the Ministry of Labour and Social Welfare. Some of the companies approached would only participate in the introductory meeting, phone interview and complete half way on the survey before they quit. In national expert's opinion, the reason could partly be the fact that it would take their staff's time and there was no incentive for them to participate as well as lack of willingness in sharing data on their project.
- The COVID-19 lockdowns also presented additional challenges during the data collection period.

Lessons learned from the Benefit-Cost Ratio (BCR) results:

Construction Company in Lao PDR	BCR	Number of Manpower	Project Size	Safety Audit	Safety Training	LTIFR	Incident per 1 million manhour	OSH/ Contract Value
Company 1	**0.71**	65	Medium	210	80	0	10.26	2.8%
Company 2	**1.36**	85	Medium	78	18	0	12.57	0.7%
Company 3	**1.36**	115	Medium	8	4	1.49	5.96	0.4%
Company 4	**0.85**	65	Medium	21	75	1.81	23.54	4.2%
Company 5	**2.01**	150	Medium	3	18	1.54	30.86	2.0%
Company 6	**2.44**	35	Small	5	3	0	76.53	2.5%

Based on the BCR results of the six construction projects surveyed, the following are some of the national expert's key observations / lessons learned:

1. The BCRs range from 0.71 to 2.44, with an average ratio at 1.46, which indicates that the benefits of OHS programs outweigh their costs overall; this affirms that occupational safety and health is an investment with return and should not be viewed as just additional costs to the project.

2. Only two out of the six projects surveyed have the calculated BCRs slightly less than 1; it is worth noting that those two projects also have the highest percentage of the OSH- related investment to the contract value of each of the projects (2.8% and 4.2% for Company 1 and Company 4, respectively);
3. Larger size projects (with manpower over 85 people in this case) appear to have better BCR results (with an exception of Company 6's project). This may suggest that projects with larger workforce would reap more benefits from the OSH programs.

These findings can be used to help companies (and relevant stakeholders) in designing and implementing safety and health programs in the workplace. First of all, the study shows that there is a systematic way to quantify benefits in order to justify an OSH program for a construction project. This BCR approach can also help estimate an appropriate investment amount on an OSH program based on the workforce size and OSH targets of a construction project. The findings can also be used as a case study to raise awareness in the importance of implementing occupational safety and health, not only from the compliance perspective, but a worthwhile and value-adding undertaking.

For a BCR analysis is able to be done accurately, companies are advised to ensure good recordkeeping and reporting of OSH incidents, injuries and work-related illnesses that occur within their project as well as records of the actual expenses and activities related to the project's OSH programs.

As an additional thought, there has never been this kind of research project on OSH for the construction sector in Lao PDR. This study gives valuable information to improve understanding of benefits of OSH programs in construction projects. It is recommended that there are more of similar research projects in the future.

Conclusion

The construction industry is an important, fast growing sector in Lao PDR, but it also among the most dangerous working environments – OSH incidents, injuries and even deaths occur in construction sites. This study surveyed six Lao construction companies in various industries in order to conduct a BCR analysis to understand the benefit of occupational safety or health program in the construction sector as well as gaining knowledge on how economic rationale can be employed to justify the implementation of an OSH program at construction sites. The study has provided valuable insights on the current state of safety and health, and the findings suggest that the benefits likely outweigh their costs when it comes to investing and implementing OSH programs. Having said that, in Lao PDR, there are challenges with regards to collecting data, as most companies currently neither keep good OSH records nor report any workplace injuries. Nevertheless, this study is a good start and its findings can be used to help companies and relevant stakeholders in designing and implementing safety and health programs in the construction sector.

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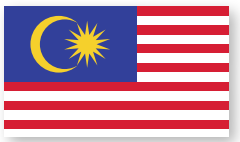


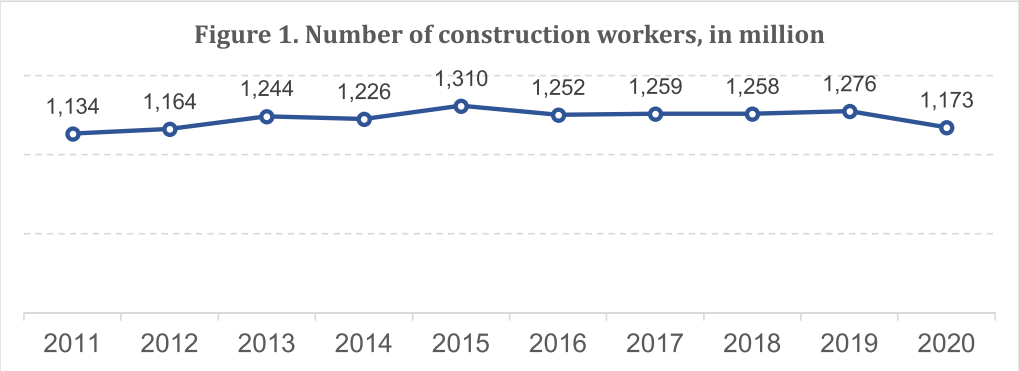
MALAYSIA

I. Introduction

The construction industry is very diverse and has significant synergy with other industries. Construction projects can range from large projects carry out by big contractors on one extreme, to small projects contracted to small contractors on the other extreme. In general, it covers employers and workers engaged in the construction of buildings and engineering structures.

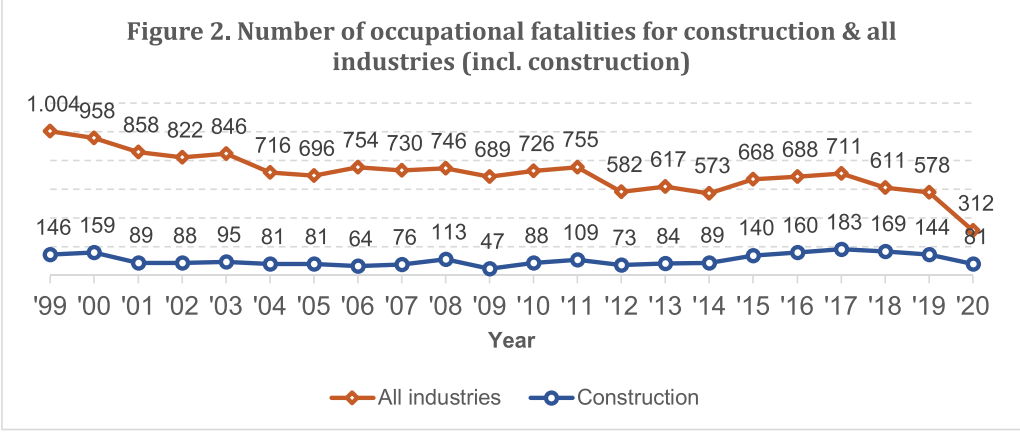
The total employment in the industry over 10 years period is over 1.1 million (see Figure 1), with 10-year average of 1.23 million workers. These include manual workers, skilled workers, managers, supervisors and professionals such as architects, engineers and quantity surveyors, which represents around 9% of the nation workforce.

Figure 1. Number of construction workers, in million



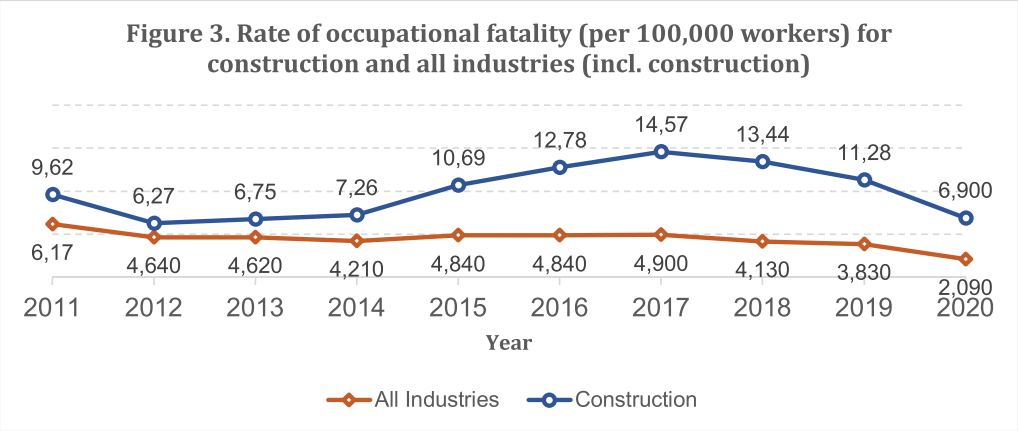
Construction remains one of the most hazardous industries, contributing about just over one- quarter (26%) of all fatalities to workers (81 workers died in construction-related accident, out of 312 work-related fatalities in 2020). About half of the fatality cases were related with working at heights. The number of fatalities of construction workers showed considerable downward trend in recent years, following a more significant, a long-term downward trend for the number of fatality in all industries, as shown in Figure 2.

Figure 2. Number of occupational fatalities for construction & all industries (incl. construction)



In the five years, from 2016 to 2020, 737 construction workers have died, with five-year average of 147 fatalities per year, about 29% higher than the five-year average from 1999 to 2003). The industry has an appreciably higher rate of fatality (6.9 per 100,000 workers) as shown in Figure 3, that is more than thrice, compared to the average fatality rate across all industries (2.09 per 100,000 workers).

Figure 3. Rate of occupational fatality (per 100,000 workers) for construction and all industries (incl. construction)



The industry is very important to the country, contributes about 4% of the nation's Gross Domestic Products (GDP). The economic outlook for the construction industry is encouraging[2] and is projected to increase by 11.5% in 2022, given several government-backed engineering construction projects. Nonetheless, this brings with it challenges to the safety and health as more people will be involved in and affected by the construction activities, and hence exposed to the risks (members of the public included).

Implementing occupational safety and health (OSH) program in a construction project has always been a challenge, partly due to its transient working nature and multiple employers' involvement. The stakeholders of the industry also perceive that the costs spent for the program are usually much expensive than the gained benefits. OSH program in the construction site can be implemented only if its benefits, namely reduced or avoided costs, outweigh the actual costs of implementing the program.

The reduced or avoided costs are mainly associated with accident costs. The Department of Occupational Safety and Health (DOSH) of Malaysia developed on-line OSH Accident Cost Calculator for employers to estimate how much accident cost to their organisations. The total cost of accident is the sum of its direct costs, indirect costs, payment and immeasurable costs. However, like any other accident

2 2 Refer to Economic Outlook 2022 by the Ministry of Finance Malaysia, which can be accessed online here: https://budget.mof.gov.my/pdf/2022/economy/economy-2022.pdf

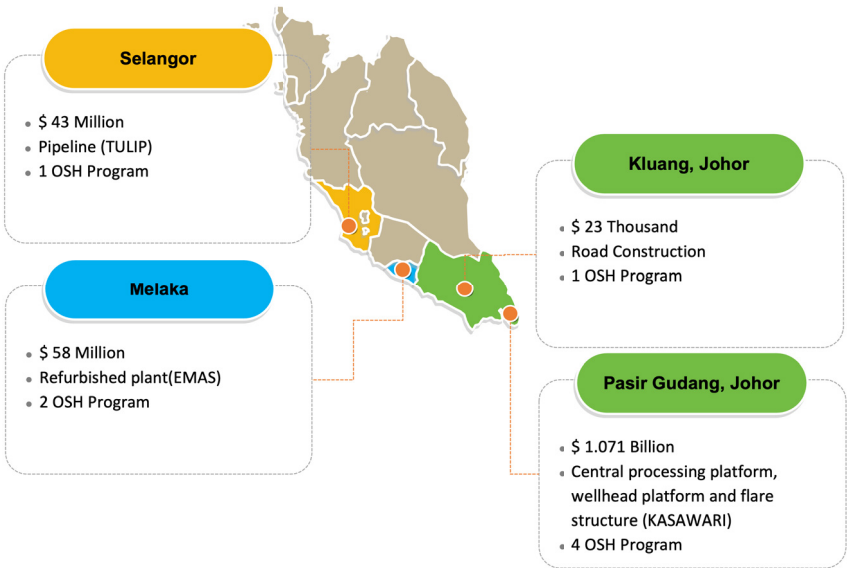
cost calculator, the tool is not effective in assisting employers to develop effective and efficient OSH management systems[3].

However, identifying the benefits of implementing ant OSH program can be challenging due to the difficulties in correctly classifying and quantifying the monetary benefits. The ILO suggests the use of direct and indirect costs. Direct costs are associated with an injury, for examples medical costs or property damage, which can be easily identified. Other costs such as indirect and hidden costs are more difficult to be identified and estimated. A more systematic approach is by using the cost benefit analysis.

The cost benefit analysis (CBA) is defined as a method that enables broad comparisons of costs and benefits to be made. The analysis consists of identification of both direct and indirect costs as well as benefits and measure them. The benefits include the costs of accidents that employer's incur which can be avoided through effective safety and health management.

This study attempts to quantify the direct and indirect of both cost and benefit of OSH programs in construction site in Malaysia. A systematic approach in determining the benefit of OSH program in the construction industry from economic perspective were collected from four engineering construction projects in Johor (2 sites), Melaka (1 site) dan Selangor (1 site) states of Malaysia. All projects were located in Peninsular of Malaysia, as shown in Figure 4.

Figure 4. Details of location, cost of project, nature of project and number of OSH program.



3 3 Ikpe, E., Hammond, F. and Proverbs, D. (2008) Cost-Benefit Analysis of Health and Safety Management: A Theoretical Discussion.

II. Results

II.1. Site 1: Small project

Site 1 was a small-sized project, which involved a small contractor of having 5 workers. The project was resurfaced of federal road in Kluang, Johor. The project was owned by the Government and the construction period was 1 month. The cost of the project was about USD23 thousands. The name of the contractor was not mentioned as part of the agreement between the authors and the contractor for participating in this research.

There was one OSH program selected for this reasearch. The OSH program was a statutory requirement for all contractors in Malaysia to ensure all workers working in their site have gone through a safety induction course, called Green Card. Details of data collected for the project is listed in Table 1. This mandatory safety course must be attended before workers can work in construction sites. The total cost to implement the program was USD200.00.

Table 1. Details of site 1 – small-sized contractor.

No	Question	Response
1	Number of working days in this project	40
2	Typical number of the workforce (including contractors)	5
3	Total amount invested by the company for OSH programs for this project (US$)	59.52
4	Number of near-miss per 1 million man-hours	625
5	Number of first aid per 1 million man-hours	0
6	Number of incidents resulting in damaged equipment/ property (more than US$100) per 1 million man-hours	0
7	Number of incidents per 1 million man-hours	625
8	Number of injured workers per 1 million man-hours	0
9	Number of fatalities per 1 million man-hours	0
10	LTIFR (*Lost Time Injury Frequency Rate*)	0
11	Working days lost due to incidents	0
12	Compensation paid due to accidents (US$)	0
13	Number of safety audits for the project	0
14	Number of safety training for the project	1

II.2. Site 2: Medium project 1

Site 2 was a medium-sized project, with the contractor of having less than 200 workers. The project involved refurbishment of a factory in Tangga Batu, Melaka. The project was owned by a private organisation and the construction period was 27 months. The cost of the project was about USD57 millions. Details of data collected for the project is listed in Table 2.

There where two OSH programs data collected for this project. The first OSH program was called "I AM HSE". This was a big program consisted of many small activities such as safety audit, campaign, training and safety inspection. The contractor of the project was unable to provide details cost for each activity and therefore proposed to submit the program as a whole. In addition, as this program was implemented as a whole, it was also difficult to determine the impact and benefit associated with each activity. The total estimated cost to implement this program was USD5,785,714.29.

The second OSH program selected from this project was a camera and artificial intelligence system used to detect safety incompliance by workers. The program was used to detect and warn unsafe act by workers. The total cost to implement this program was USD85,714.29.

Table 2. Details of site 2 – medium-sized contractor.

No	Question	Response
1	Number of working days in this project	648
2	Typical number of the workforce (including contractors)	200
3	Total amount invested by the company for OSH programs for this project (US$)	5,785,714.29
4	Number of near-miss per 1 million man-hours	0
5	Number of first aid per 1 million man-hours	0
6	Number of incidents resulting in damaged equipment/ property (more than US$100) per 1 million man-hours	0
7	Number of incidents per 1 million man-hours	0
8	Number of injured workers per 1 million man-hours	0
9	Number of fatalities per 1 million man-hours	0
10	LTIFR (*Lost Time Injury Frequency Rate*)	0
11	Working days lost due to incidents	0
12	Compensation paid due to accidents (US$)	0
13	Number of safety audits for the project	3,240
14	Number of safety training for the project	14

II.3. Site 2: Medium project 2

Site 3 was a medium-sized project, with the contractor of having less than 200 workers. The project involved construction of a natural gas pipeline in from Puchong to Klang for future development of power plant in Selangor. The project was owned by a private organisation and the construction period was 25 months. The cost of the project was about USD 43 millions. Details of data collected for the project is listed in Table 3.

There was only one OSH programs used for this study. The OSH program was called "Respect and Care Program". This program consisted of top management showing commitment on matters related with safety and health. There were several activities implemented under this program, such as

love letter from family to the worker, top management site visit and audit by project management team. As the program was not carried out independently, it was difficult to differentiate the benefits for each activity. And hence these activities were taken as a program. The total cost to implement the program was USD1,309,523.81.

Table 3. Details of site 3 – medium-sized contractor.

No	Question	Response
1	Number of working days in this project	600
2	Typical number of the workforce (including contractors)	400
3	Total amount invested by the company for OSH programs for this project (US$)	1,309,523.81
4	Number of near-miss per 1 million man-hours	0.83
5	Number of first aid per 1 million man-hours	0
6	Number of incidents resulting in damaged equipment/ property (more than US$100) per 1 million man-hours	0
7	Number of incidents per 1 million man-hours	0
8	Number of injured workers per 1 million man-hours	0
9	Number of fatalities per 1 million man-hours	0
10	LTIFR (*Lost Time Injury Frequency Rate*)	0
11	Working days lost due to incidents	0
12	Compensation paid due to accidents (US$)	0
13	Number of safety audits for the project	347
14	Number of safety training for the project	9

II.4. Site 4: Large project

Site 4 was a large-sized project, with the contractor of having more than 200 workers. The project involved construction of oil and gas facility in Pasir Gudang, Johor. The project was owned by a private organisation and the construction period was 18 months, details as in Table 4.. The cost of the project was about USD 1.071 billions. There were four OSH programs data collected from this project, namely:

a. Leadership Area based Demarcation Program (Total cost spent, USD51,904.76)
b. Quarterly Top HSE Risk Campaign & Awareness (Total cost spent, USD48,809.52)
c. HSE Appreciation & Recognition (Total cost spent, USD333,333.33)
d. Proactive Intervention Culture (Total cost spent, USD126,190.48)

Table 4. Details of site 4 – large-sized contractor.

No	Question	Response
1	Number of working days in this project	1,290
2	Typical number of the workforce (including contractors)	5,000
3	Total amount invested by the company for OSH programs for this project (US$)	1,023,809.52
4	Number of near-miss per 1 million man-hours	0.17
5	Number of first aid per 1 million man-hours	0
6	Number of incidents resulting in damaged equipment/ property (more than US$100) per 1 million man-hours	0.02
7	Number of incidents per 1 million man-hours	0.21
8	Number of injured workers per 1 million man-hours	0.02
9	Number of fatalities per 1 million man-hours	0
10	LTIFR (*Lost Time Injury Frequency Rate*)	0
11	Working days lost due to incidents	0
12	Compensation paid due to accidents (US$)	0
13	Number of safety audits for the project	234
14	Number of safety training for the project	500

III. Discussion and Conclusion

This study is very important to ensure that every OSH program is 'value for money'. It is also important tool to measure the OSH program has achieved its objectives. This study also highlighted the ratio of costs spend for OSH to the overall cost of the project. The OSH programs included in this analysis are selected few that the contractors have data on cost spent for the OSH programs and their perceived benefits. There are other OSH programs carried out by contractors in their construction sites but not included in this study, which may also contributed to the overall effective safety and health management.

Different categories of contractors invested different costs for OSH. Large project (MY3, MY6, MY7 and MY8) spends more than medium (MY2, MY4 and MY5) and small projects (MY1). However, the ratio analysis (as in Table 5) shows that, in proportion to the project contract value, medium and small projects are spending more on OSH programs than large project. One of the ratios for medium project (MY4) is lower than the small project (MY1). The result of this study is not consistent with Ikpe *et al.* (2012)[4], who reported the ratio for small project is higher than both the medium and large projects.

4 Ikpe, E., Hammon, F., Oloke, D. (2012). Cost-Benefit analysis for accident prevention in construction projects. Journal of Construction Engineering and Management, 138(8), 991-998.

The benefit-cost ratio (BCR) reveals that benefit are greater than the cost for all OSH programs. Large project (MY3, MY6 and MY8, with exception for MY7) recorded highest ratio, then medium (MY2, MY4 and MY5) and small (MY1) projects. This makes a good business case for encouraging projects to carry out preventive OSH programs because these initiatives would result in benefits that are measurable. The average ratio for all projects is 2.43:1, which can be used to estimate the accident prevention cost. This is slightly lower than Ipke *et al*. (2012)[5] who reported ratio of 3:1 in the United Kingdom.

Table 5. Ratio of total OSH cost to the overall project cost and the benefit-cost ratio.

	MY1-S	**MY2- M**	**MY3-L**	**MY4- M**	**MY5- M**	**MY6-L**	**MY7-L**	**MY8-L**
Project Contract Value, USD **(A)** x000	23.8	43,473.1	1,071,428.6	57,857.1	57,857.1	1,071,428.6	1,071,428.6	1,071,428.6
Amount Invested on OSH, USD **(B)** x000	0.2	1,309.5	1,023.8	85.7	5,785.7	1,023.8	1,023.8	1,023.8
Ratio, % **(B/A)**	0.84	3.01	0.0956	0.148	10	0.0956	0.0956	0.0956
BCR	1.38	1.60	5.12	1.62	1.14	5.33	1.38	4.64

Data collection process (challenges faced)

There were several challenges that were noteworthy to be mentioned. It is generally defined in Malaysia that the construction industry is divided into two main types, namely building constructions and engineering constructions. At the beginning of the study, it was decided to collect samples from both types of construction industry. However, this was not possible due to unreadiness of the contractors from building constructions, partly due to restrictions by Covid-19 situation at sites. All samples reported in this study was from the engineering constructions.

Other challenges were on the familiarity of the contractor (and also the consultant) on the study. This was mainly due to the fact that this study was the first of its kind conducted, perhaps in Malaysia. Details on the cost to implement the OSH programs were not well recorded, and the benefits gained were also difficult to estimate. This was caused by the unclear objectives of the OSH programs was conducted. In addition, the effectiveness of the OSH programs was also not assessed after the programs were completed.

In each project surveyed in this study, there were several OSH programs implemented. The benefits and cost avoided one program were difficult to be separated or differentiated as the benefits and cost avoided were viewed as the results of OSH programs as a whole. In three visited sites, there were no accident

5 See note 1

occurred, and therefore it was difficult to estimate the cost avoided by not having the accident.

Lessons learned from the BCRs collected

The study should be continued so that more data can be collected, to fairly represent the industry. The data from this study was only collected from the engineering construction projects. Data should also be collected from the building construction projects. The employer should also has clear objective on why OSH program is introduced to his site and has means to measure its success. Without these at the beginning of the OSH program, it will be difficult to carry out the cost benefit analysis.

Conclusion

This study is the first attempt to use the CBA to assess the OSH programs in construction projects. The samples are limited to engineering construction projects and do not include the building construction projects. The benefit-cost ratio (BCR) reveals that benefit are greater than the cost for all OSH programs, signifying a good return for any OSH investment. The benefit to cost ratio of 2.43:1 is very significant to provide economic justification for OSH programs in the construction industry in Malaysia. The results further highlight the enormous benefits of implementing OSH programs in construction projects.

National Report

RESEARCH ON ECONOMIC JUSTIFICATION OF OCCUPATIONAL SAFETY AND HEALTH (OSH) IMPLEMENTATION IN THE CONSTRUCTION SECTOR

THE PHILIPPINES

I. Introduction

The World Bank report on the Philippines indicated the increasing trend in construction due to the government's strategy of "Build, Build, build" infrastructure program. The growth decelerated due to the pandemic but is expected to increase in 2022. The total value of construction contracts in 2020 amounted to PhP 275.81 billion, or USD 5.4 billion (JD Supra, 2021). The Philippine government aims to spend at least 7% of its gross domestic product for construction (Feria & Ocampo, 2020).

The increase in the number of construction projects is also expected to have a significant impact in safety-related incidents in the construction industry. Lu (2022) reported the prevalence of occupational injuries in the construction industry but there are no details as to the nature of the injuries.

In the Philippines, the Occupational Safety and Health Center (OSHC) under the Department of Labor and Employment (Dole) is tasked to handle matters pertaining to safety and health at work (Mawis, 2019).

Construction workers must be oriented, instructed and trained by the construction project manager to assure safe handling of equipment and of disposing waste. All employees must have protective equipment for the eyes, face, feet and all crucial body parts when exposed to hazardous work procedures. A safety officer is required onsite for every ten units of heavy equipment to ensure proper handling (Mawis, 2019).

Many of these construction projects implement OSHC's policies and other provisions from the Labor Code to ensure worker safety. As per OSHC issuance, violations against workplace health and safety standards would be reported and evaluated by the Philippine Contractors Accreditation Board (PCAB).

A literature search on construction safety in the Philippines yielded very limited results especially scholarly articles. Data obtained were based on news articles that did not give specific details or analysis of the accidents. Thus, this particular study aims to add to the dearth of literature in this area by looking into the occupational health and safety practices of construction companies. Specifically, the project aims to:

II. Results

There are six companies that participated in this project with the following profile: 3 big, 1 medium, and 2 small. The companies were classified based on the guideline provided by the Philippine Contractor's Accreditation Board (PCAB) in Figure 1.

Figure 1. Classification of Construction Companies in the Philippines

Third Stage of Adjustment on Allowable Ranges of Contract Costs (ARCC) and Single Largest Project (SLP) Completed / Track Record Requirements (Board Resolution No. 201, series of 2017)			
Size Range	**License Category**	**Single Largest Project (₱)**	**Allowable Ranges of Contract Costs (₱)**
Large B	AAAA and AAA	Above 225 Million	< or above 450 Million
Large A	AA	Above 150 Million up to 225 Million	Up to 450 Million
Medium B	A	Above 75 Million up to 150 Million	Up to 300 Million
Medium A	B	Above 15 Million up to 75 Million	Up to 150 Million
Small B	C & D	≤ 15 Million	Up to 30 Million
Small A	Trade/E	Up to 1 Million	Up to 1 Million
Note: Par. 3 of Sec. 23.11.2 of the IRR of RA 9184 allows Small A and Small B contractors without similar experience to bid only for contracts not more than fifty percent (50%) of the allowable range of contract cost of their respective size range(s).			

II.1. PH1

PH1 is a medium-sized company that specializes in construction of residential and non-residential buildings, pipelines, transportation of liquids. The company project included in this report is a total pipe replacement along a section of road. The contract value is USD 1,583,301. The company invested USD 57,600 for Occupational Safety and Health programs related to the project.

The project duration was 180 days. It had one near-miss per one million hours, one safety audit, and one safety training. There were no recorded injuries or accidents so there were no lost times. The company has a Safety Officer, a Safety Supervisor, and a Secretary/Administration located on the site. Aside from this, they have a Safety Manager in the main office.

The project was able to implement the following OSH programs: identify WSH hazards, evaluate and control risks, working at height, and confined space. Some of the benefits of the OSH program are as follows:

- Increases productivity and efficiency
- Prevents injuries and illnesses from occurring
- Workers will be engaged with safety as well as their individual responsibilities

The main items of expense for the OSH programs are on procurement of tools and machines, training, insurance, salaries of OSH personnel, maintenance of health facility and signages.

The costs avoided due to the implementation of the program are: first aid, administration, hospitalization, medical personnel, medicines, rehabilitation,

compensation, insurance, accident investigation such as payment for investigator and investigation consumables. Since there are no accidents they also saved in hiring temporary staff that will replace those that were injured.

The computed benefit-cost ratio (BCR) is 0.34.

II.2. PH2

PH2 is one of the leading firms in engineering and construction in the Philippines. It is well-known for its innovative solutions in the field of construction. It is classified as a big company that employs around 4,000 employees. It partners with the Philippine government in the construction of schools and airports among others.

The company project included in this report is a housing project that took 3 years. The contract value is USD 8,819,053. The company invested USD 400,000 for Occupational Safety and Health programs related to the project.

The project duration was around 900 days. It had 14 Near miss per 1 Million man-hour (28 Near- misses recorded in 2,000,000 man-hours), 46.5 First aid cases per 1 million man hours (93 recorded), and 16 Damage equipment/ property per 1 million man -hour (32 incidents). There were 36 safety audits, and Minimum 4 trainings per year (Basic Fire, 8 Hours Mandatory, Basic Crane rigging, Housekeeping. There were no recorded injuries or accidents so there were no lost times due to injuries. The company has a Safety Officer located on the site. Aside from this, they have a Safety Administrator in the main office.

The project was able to implement the following OSH programs: hazard identification and risk assessment and control. It involved identifying hazards in the workplace, conducting assessments and managing risk.

The costs incurred because of the OSH program implemented are as follows: procurement of construction tool such (Cranes, Travel lift), Employee training/ operator, operations Labor, maintenance of Heavy Equipment/Tools, Safety management, promotion of OSH by giving award for Safe worker of employee/ Awardee, insurance, salaries of Safety Officer and Safety Admin, Clinic operations, Warning/Information signages, MOA with Hospitals/ Consultants, and Social Development Programs.

The highest medical expense avoided was for tests/x-rays and operation followed by expense for medical personnel. There was also significant savings for insurance, equipment damage and preventive maintenance.

The most significant benefit attributed to the project is having more clients and staff commitment and improvement. Although there was an expense for damaged product, the OSH program was cited to have contributed to savings in material damages.

The computed BCR for the project is 1.25.

II.3. PH3

PH3 is a large company that develops large-scale, mixed-use, planned communities incorporating residential, commercial, educational, and leisure components. . It is known for projects such as town centers, skyscrapers, resorts in all parts of the Philippines. It is estimated that the company employs more than 6,000 employees.

The company project included in this report is a building project that took 3.9 years. The contract value is USD 1,513,910,928. The company invested USD 732,510 for Occupational Safety and Health programs related to the project.

The project duration was around 1170 days. It had 2.4 Near miss per 1 Million man-hour, 12.6 First aid cases per 1 million man hours, 0.3 incidents resulting in damaged equipment per 1 million man- hours, 16.5 incidents per 1 million man-hours, 0.3 injured worker per 1 million man-hours, 0.9 Lost Time Injury Frequency Rate (LTFIR), and spent USD 3,636 compensation due to accidents. There were 4 safety audits and 49 trainings conducted for the project.

The company has a Safety Officer located on the site. Aside from this, they have a Safety Manager in the main office.

The project was able to implement toolbox talk as a safety and health program. It is an informal discussion about safety issues in the workplace.

The costs associated with the OSH program implemented are as follows: procurement of safety tools and equipment, Employee training from internal and external sources, salary for safety officer/manager, maintenance, promotion of OSH, medical insurance, maintenance of health facility on-site, and Warning/Information signages. Insurance and safety signages are the largest costs incurred.

There are many costs avoided due to the OSH program. For medical expense, the highest is on hospitalization and insurance costs. For equipment, the highest avoided cost is due to damaged equipment and repair cost. There were also costs avoided due to damaged material, damaged finished work, loss time due to injuries, overtime costs and hiring of temporary staff.

The most significant benefit attributed to the project is productivity improvement. The computed BCR for the project is 1.23.

II.4. PH4

PH4 is a small construction company that specializes in residential and non-residential buildings.

The company project included in this report is a layout, fabrication, and installation of a gas pipeline that took 6 months to finish. The contract value is USD 9,264. The company invested USD 557 for Occupational Safety and Health programs related to the project.

The project duration was around 25 days with 7 personnel. There is no near miss per 1 Million man- hour and only one first aid cases per 1 million man hours. There were 32 safety audits and 8 hours of training per person.

The company has a First Aider located on the site. Aside from this, they have a Safety Manager in the main office.

The project was able to implement toolbox meeting as a safety and health program. It is an informal discussion about safety issues in the workplace. Some of the OSH initiatives undertaken are:

- Composition and Duties of Health and Safety Committee- SLHBTC Working Area-All personnel.
- Tool Box/ Safety Meeting, Job Safety Analysis- SLHBTC Working Area - All Personnel.
- Personnel Protective Equipment - SLHBTC Facility - All Personnel.
- Safety Signages - SLHBTC Working Area- All Personnel.
- Welfare Facility - SLHBTC Toilet, Rest & Eating Room etc. - All Personnel

The costs associated with the OSH program implemented are as follows: procurement of tools and equipment, safety training, salary for first-aider, maintenance, promotion of OSH, zero-accident cash incentive, daily exercise and project safety execution plan, group insurance, stretcher, Warning/ Information signages, and safety meeting. Insurance is the largest cost component.

There are many costs avoided due to the OSH program. For medical expense, the highest is on accident insurance. For equipment, the highest avoided cost is due to damaged equipment and repair cost. There were also costs avoided due to damaged material, damaged finished work, loss time due to injuries, overtime costs and hiring of temporary staff. The value of lost-time due to work stoppage was valued highly.

The most significant benefits attributed to the project are good company image, productivity improvement, and staff commitment improvement. The company believed that the project finished early because of the OSH program.

The computed BCR for the project is 1.21.

II.5. PH5

PH5 is a small company that is involve in design, implementation and general construction of residential condominium units, shopping centers, resorts, educational facilities and similar projects.

The company project included in this report is involved masonry works and exterior finishes that took 2 years to finish. The contract value is USD 2,700,000. The company invested USD 27,000 for Occupational Safety and Health programs related to the project.

The project duration was around 700 days with 300 personnel per day. It had 5 Near misses per 1 Million man-hour, 3 First aid cases per 1 million man hours, and 1 injured worker per 1 million man-hours. There were 2 safety trainings conducted for the project.

The company has a Safety Officer located on the site. Aside from this, they have a Safety Team Leader in the main office.

The project was able to implement Construction Safety and Health Program as required by the Department of Labor and Employment. The company was committed to eliminate all work-related injuries and to carry out all activities with proper regard to the environment. Supervisors were given the responsibility for the safety of employees and as a part of their daily duties must check the workplace for unsafe conditions, watch employees for unsafe actions and take prompt action to eliminate any hazards.

The costs associated with the OSH program implemented are as follows: procurement of hard hat, safety harness, goggles and other PPEs, installation of guard rails, safety training, salary for safety personnel, insurance, and medicines. The procurement of PPEs is the largest component of cost.

There are many costs avoided due to the OSH program. For medical expense, the highest is on administration, followed by medical and medicine cost. The most significant benefits attributed to the project are good company image and staff commitment improvement.

The computed BCR for the project is 11.14.

II.6. PH6

PH6 is a large company that is involved in building water and waste water infrastructures for the government.

The company project included in this report is related to automation and instrumentation that took 6 months to finish. The contract value is USD 386,764. The company invested USD 13,669 for Occupational Safety and Health programs related to the project.

The project duration was around 210 days with 15 personnel per day. There are no near misses, incidents, or accidents. There were 5 safety audits and 5 safety training conducted for the project.

The company has a Safety Officer located on the site.

The project implemented the occupational and health policy that involved safe work practices, risk management, safety allocation of responsibility, accident reporting, use of PPEs and emergency preparedness.

The costs associated with the OSH program implemented are as follows: procurement of PPEs, safety training, OHS planning and preparation, insurance, salaries of safety personnel and safety signs. Safety training is the largest component of cost followed by salaries of safety personnel.

There are many costs avoided due to the OSH program and most of them are medical-related costs such as first aid, check-up by nurse or doctor, and accident investigation. For medical expense, the highest is on administration, followed by medical and medicine cost. Hiring of temporary staff was also included as a cost avoided since there are no accidents.

The most significant benefits attributed to the project are good company image and staff commitment improvement.

The computed BCR for the project is 0.42

III. Discussion & Conclusion

Although the number of construction projects in the Philippines continue to increase because of the government's infrastructure program, there is a dearth of studies in the field of construction safety. A search in the Internet and the Scopus database yielded less than 2 studies conducted on construction safety in the Philippines. The search results, however, is replete with recent construction accidents. Thus, this particular project provides researchers a direction for future studies in the field of safety. It can also help the government find research grants to entice research institutes to embark in projects that will benefit the construction industry and craft laws that will ensure safety in the construction site.

Data gathering for this project was facilitated by the Occupational Safety and Health Center through its connection with Philippine Contractors Accreditation Board (PCAB). The requirement for financial and safety data made it difficult for many companies to participate readily without the express approval of top management. The companies had to be assured that they will remain anonymous because the data they share may be used against them in the end.

One of the challenges faced in the data gathering process is completeness of data. Some companies opted to fill out the questionnaire with the use of the guide. However, after final inspection, they were not able to include non-tangible benefits such as improvement in image and commitment of the workers. It is possible that the person filling out the questionnaire is not experienced enough to make appropriate estimates. Hence, they were interviewed via Zoom for clarification. They were given examples on how to compute for estimated benefit in relation to the project.

Most of the benefit-cost ratio computed are a little higher than 1. This is especially true for large construction companies that have higher investment in OSH. It is also possible that these companies were not able to put a reasonable estimate to potential for new business and a good corporate image. Large companies have a lot of goodwill and they might think that the brand image is helping them to win clients and not their safety record. These companies will only know the benefit of safety if they lose clients because of it.

The findings of the study can be used as benchmarks by other construction companies in the Philippines in allocating budget for OSH and also gathering and monitoring safety data. Construction companies will get a realistic estimate on the percentage of cost associated to OSH and can put it in the budget. Data on accidents and incidents can also be used as standard key performance indicators in the construction industry.

The initiative of ASEAN in conducting this project should provide an impetus for the Philippines to continue to the study and gather data from 30 randomly selected companies belonging to small, medium, and big. The random selection is necessary because it is only through the use of this method that the correct safety picture can be gleaned. It is reasonable to assume that the companies that participated in this round of data gathering are compliant. They are mostly large companies that are well-known in the industry and have processes in place.

One of the good contributions of this study is the realization that safety has financial benefits in terms of cost avoided and future revenue prospects. The questionnaire specifically identified the intangible benefits that need to be quantified and respondents were forced to think about the correct values. There is a tendency for many people to disregard safety because they do not know the costs of being unsafe. The questionnaire was also able to enumerate the potential costs of accident which can prompt project managers to think about losses.

The BCRs computed for the participating companies were mostly small except for one company that saw safety as a means of getting more clients. This point of view can be shared with other construction companies through this study. Other companies can be taught to estimate the benefit of safety coming from repeat clients.

Conclusion

Findings from this study suggest that keeping a safe workplace has significant financial benefits. This study enabled the Philippines to learn the safety invest of construction companies and their perceived benefits. All companies have incorporated safety in their culture as it is part of the requirements of the government. Most of the BCRs computed are a little higher than one especially for big construction companies.

National Report

RESEARCH ON ECONOMIC JUSTIFICATION OF OCCUPATIONAL SAFETY AND HEALTH (OSH) IMPLEMENTATION IN THE CONSTRUCTION SECTOR

SINGAPORE

I. Introduction

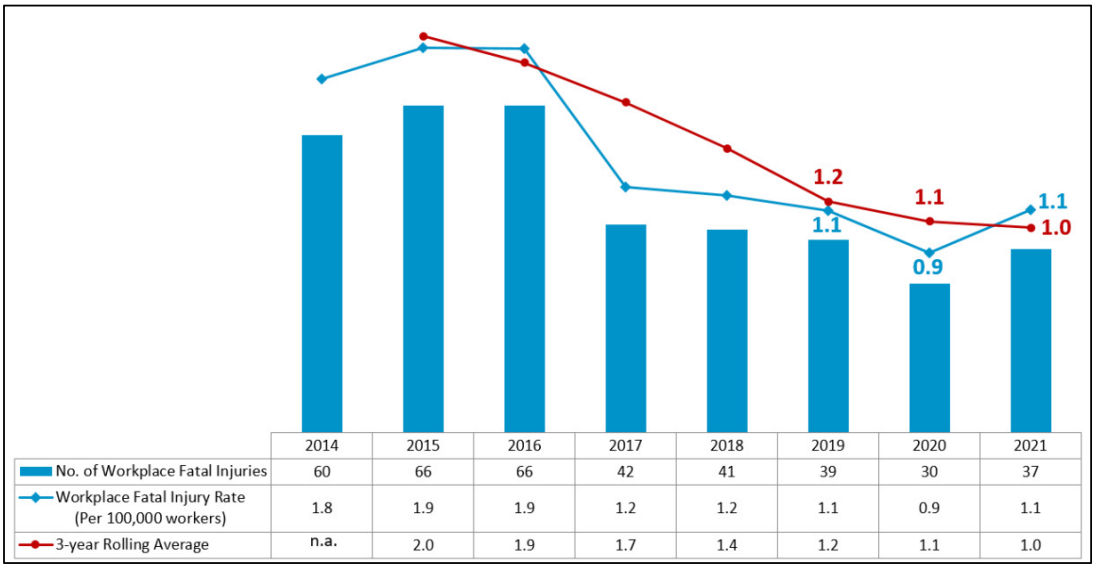
The construction sector is one of the key drivers of Singapore's economy. Construction demand in Singapore in 2022 is projected to be between S$27 billion and S$32 billion, with the public sector expected to contribute about 60 per cent of the total demand, as reported by the Building and Construction Authority (BCA).

The construction demand in the public sector is projected to be between S$16 billion and S$19 billion, supported by the strong pipeline of housing projects including those under the Home Improvement Programme, as well as healthcare developments and infrastructure works such as the Cross Island MRT Line (Phase 1). Meanwhile, the private sector construction demand is expected to reach between S$11 billion and S$13 billion this year, comparable with the volume in 2021.

Given the dynamic increase in the construction sector, the mandate for a safer and healthier workplace plays an even bigger role in ensuring the safety and health in every workplace.

In Singapore in 2021, there were 37 workplace fatal injuries, two fatal injuries fewer compared to 39 in the pre-COVID year 2019. The workplace fatal injury rate remained at 1.1 fatal injuries per 100,000 workers, the same as 2019.

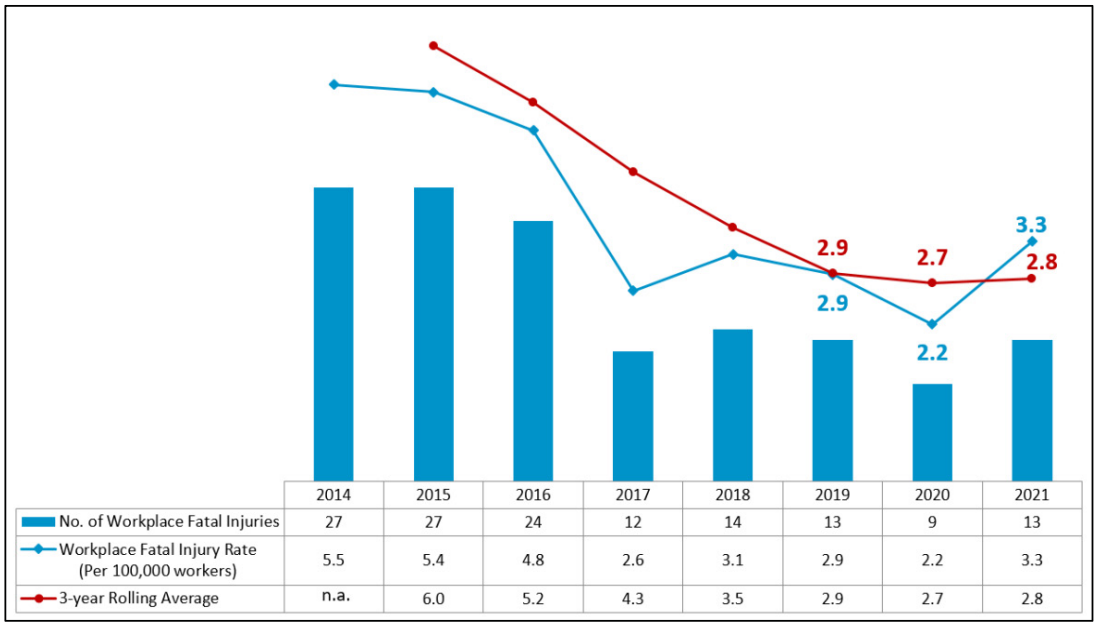
Figure 1 – Number and rate of workplace fatal injuries, 2014-2021



	2014	2015	2016	2017	2018	2019	2020	2021
No. of Workplace Fatal Injuries	60	66	66	42	41	39	30	37
Workplace Fatal Injury Rate (Per 100,000 workers)	1.8	1.9	1.9	1.2	1.2	1.1	0.9	1.1
3-year Rolling Average	n.a.	2.0	1.9	1.7	1.4	1.2	1.1	1.0

Construction was one of the top contributors to fatal injuries in 2021 with 13 fatal injuries, four more than in 2020 but comparable to pre-Covid levels in 2019. The workplace fatal injury rate in construction rose from 2.9 fatal injuries per 100,000 workers in 2019 to 3.3 in 2021, due to a smaller construction workforce in 2021.

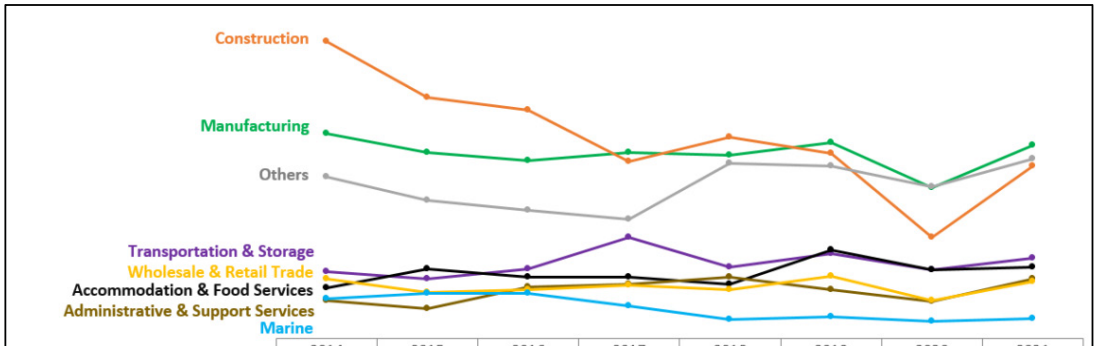
Figure 2 – Number and rate of workplace fatal injuries for Construction Sector, 2014 - 2021



	2014	2015	2016	2017	2018	2019	2020	2021
No. of Workplace Fatal Injuries	27	27	24	12	14	13	9	13
Workplace Fatal Injury Rate (Per 100,000 workers)	5.5	5.4	4.8	2.6	3.1	2.9	2.2	3.3
3-year Rolling Average	n.a.	6.0	5.2	4.3	3.5	2.9	2.7	2.8

The number of workplace major injuries increased from 463 injuries in 2020 to 610 injuries in 2021, comparable to 629 injuries in 2019 (pre-Covid) (Figure 3). The major injury rate rose from 18.1 major injuries per 100,000 workers in 2019 to 18.5 in 2021, due to the smaller workforce size in 2021. Construction sector, in 2021, was one of the sectors with highest major injuries at 126.

Figure 3 – Number of workplace major injuries by industry, 2014 – 2021



	2014	2015	2016	2017	2018	2019	2020	2021
Manufacturing	150	136	130	136	134	143	110	141
Construction	217	176	167	129	147	135	74	126
Transportation & Storage	49	44	51	74	52	62	50	59
Accommodation & Food Services	37	51	45	45	40	65	50	52
Administrative & Support Services	28	22	38	40	45	36	27	44
Wholesale and Retail Trade	44	34	36	39	36	46	28	42
Marine	29	33	33	24	14	16	13	15
Others	118	101	94	87	128	126	111	131

The Ministry of Manpower of Indonesia conducted Phase I of this research project in 2018- 2019, aiming at developing a methodology for evaluating the costs and benefits of OSH interventions and programs in the construction sector. Through

the use of questionnaires and group discussions, a total of 10 construction companies were surveyed, and relevant data on the costs and benefits associated were obtained. The net-present value and cost-benefit analysis (CBA) was further utilized in order to determine the benefit-cost ratio (BCR). Findings from Phase I demonstrated that the BCRs were roughly 0.7 to 1.6. While several challenges were found in collecting the data and quantifying the effects of an OSH program, this project demonstrated the potential of using economic rationale in justifying an OSH program.

As an ASEAN Member State (AMS), Singapore is participating and supporting Phase II of this research project, with the aim to gain knowledge and experience on how economic rationale can be employed to justify the implementation of a safety or health program in the workplace.

A total of five (5) companies were selected to take part in this National Report and the filling up of the questionnaires. We determined that cost of work-related injuries and ill health would be borne by employers, insurance or the worker/ family. Cost items linked to staffs, training programmes, operations, other related OSH risk management, investigation, equipment replacement cost, legal and prosecution costs incurred were computed as cost borne by employers. The cost borne by insurance included expenses beyond that covered by compensation for medical treatment and rehabilitation. Cost items like lack of working income and loss of future earnings were considered as cost borne by the worker/ family.

This report also aimed to identify the potential benefits of implementing OSH Programs in the construction sector by estimating the advantages in monetary terms.

All information and cost were given to the best of the ability by the companies

II. Results

II.1. Worksite SG1: Large-sized project

Worksite SG1 was a large-sized commercial project with a project contract value US$105.85million, located at the west part of Singapore. The project was a mixed development comprising a 4-Storey podium Consisting Of Retail (49 Shop Units, 49 Restaurant Units, 1 Supermarket & 1 Food court, Total: 100 Units), carparks & one child care centre And five Blocks Of 12-storey residential development above (Total: 516 Units) with communal facilities.

The project took a total duration of 36 months to complete, with a total 2,035,608 manhours worked.

No.	Question	Response
1	Typical number of workforce (average per day)	267
2	Total amt invested for OSH program (US$)	3,285,000

3	Number of near miss per 1M man hours	5
4	Number of first aid per 1M man hours	30
5	Number of incidents resulting in damaged equipment/ property (more than S$100) per 1 million man- hours	0
6	Number of incidents per 1M manhours	43
7	Number of injured workers per 1M manhours	37
8	Number of fatalities per 1M manhours	0
9	Lost Time Injury frequency rate (LTIFR)	0
10	Number of working days lost to incidents	0
11	How much spent on compensation due to accidents	97,090
12	Number of safety audits for the project	6
13	Number of safety training for the project (per Quarter)	5
14	Monthly wages of safety personnel on site (USS$)	10,585
15	Monthly wages of safety personnel in main office (US$)	6570
16	Name of OSH Program	TBM, Safety Campaign, Training
17	Program Implementation Cost (US$)	445,300

II.2. Worksite SG2: Large-sized project

Worksite SG2 was a large-sized commercial project with a project contract value of US$105.85million, located at the central part of Singapore. The project was a 10-storey commercial development comprising two storeys of retail / F&B and eight storeys of offices with one basement carpark.

The project took a total duration of 36 months to complete, with total 6,708,000 manhours worked.

No.	Question	Response
1	Typical number of workforce (average per day)	750
2	Total amt invested for OSH program (US$)	529,250
3	Number of near miss per 1M man hours	0
4	Number of first aid per 1M man hours	0
5	Number of incidents resulting in damagedequipment/ property (more than S$100) per 1 million man- hours	9
6	Number of incidents per 1M manhours	2.65
7	Number of injured workers per 1M manhours	2.65
8	Number of fatalities per 1M manhours	0
9	Lost Time Injury frequency rate (LTIFR)	2.65
10	Number of working days lost to incidents	243
11	How much spent on compensation due to accidents	161,330

12	Number of safety audits for the project	8
13	Number of safety training for the project (per Quarter)	1
14	Monthly wages of safety personnel on site (USS$)	19,929
15	Monthly wages of safety personnel in main office (US$)	225,630
16	Name of OSH Program	EHS Inspection Program
17	Program Implementation Cost (US$)	3,387,857

II.3. Worksite SG3: Medium-sized project

Worksite SG3 was a medium-sized commercial project with a project contract value of US$53.65 million, located at the central part of Singapore. The project was a 29-storey office development comprising of a 5-storey podium with 1st storey restaurant use, 2nd storey main lobby, a 3-storey car park, 2 basements with end-of-trip facilities and an underground pedestrian network.

The project took a total duration of 42 months to complete, with total 1,773,150 manhours worked.

No.	Question	Response
1	Typical number of workforce (average per day)	147
2	Total amt invested for OSH program (US$)	530,000
3	Number of near miss per 1M man hours	NA
4	Number of first aid per 1M man hours	0
5	Number of incidents resulting in damagedequipment/ property (more than S$100) per 1 million man- hours	0
6	Number of incidents per 1M manhours	4.5
7	Number of injured workers per 1M manhours	4.5
8	Number of fatalities per 1M manhours	0
9	Lost Time Injury frequency rate (LTIFR)	4.5
10	Number of working days lost to incidents	60
11	How much spent on compensation due to accidents	2,232.16
12	Number of safety audits for the project	10
13	Number of safety training for the project (per Quarter)	4
14	Monthly wages of safety personnel on site (USS$)	7,665
15	Monthly wages of safety personnel in main office (US$)	5,840
16	Name of OSH Program	Fall Prevention Program
17	Program Implementation Cost (US$)	1,615,289

II.4. Worksite SG4: Large-sized project

Worksite SG4 was a large-sized project with a project contract value US$182.015million, located at the north-eastern part of Singapore. The project was a design and build public housing project, comprising 12 Blocks Of 14-storey residential buildings with two Blocks of multi-storey carpark with substation, social community facilities, precinct pavilions & common green.

The project took a total duration of 29 months to complete, with total 4,638,250 manhours worked.

No.	Question	Response
1	Typical number of workforce (average per day)	750
2	Total amt invested for OSH program (US$)	2,190,000
3	Number of near miss per 1M man hours	2.5
4	Number of first aid per 1M man hours	4.3
5	Number of incidents resulting in damagedequipment/ property (more than S$100) per 1 million man- hours	0
6	Number of incidents per 1M manhours	1.5
7	Number of injured workers per 1M manhours	0.6
8	Number of fatalities per 1M manhours	0
9	Lost Time Injury frequency rate (LTIFR)	161
10	Number of working days lost to incidents	75
11	How much spent on compensation due to accidents	62,561
12	Number of safety audits for the project	1170
13	Number of safety training for the project (per Quarter)	21
14	Monthly wages of safety personnel on site (USS$)	10,950
15	Monthly wages of safety personnel in main office (US$)	15,330
16	Name of OSH Program	WSH Com & Coord Meeting
17	Program Implementation Cost (US$)	1,409,046

II.5. Worksite SG5: Medium-sized project

Worksite SG5 was a medium-sized commercial project with a project contract value of US$44million, located at the north-eastern part of Singapore. The project was of landed housing comprising 50 Units of three-storey semi-detached houses with attics and three units of three- storey terrace houses with attic and one basement.

The project took a total duration of 41 months to complete, with total 989,698 manhours worked.

No.	Question	Response
1	Typical number of workforce (average per day)	127
2	Total amt invested for OSH program (US$)	69,000
3	Number of near miss per 1M man hours	0
4	Number of first aid per 1M man hours	0
5	Number of incidents resulting in damagedequipment/ property (more than S$100) per 1 million man- hours	0
6	Number of incidents per 1M manhours	0
7	Number of injured workers per 1M manhours	0
8	Number of fatalities per 1M manhours	0
9	Lost Time Injury frequency rate (LTIFR)	0
10	Number of working days lost to incidents	0
11	How much spent on compensation due to accidents	0
12	Number of safety audits for the project	15
13	Number of safety training for the project (per Quarter)	40
14	Monthly wages of safety personnel on site (USS$)	9,855
15	Monthly wages of safety personnel in main office (US$)	0
16	Name of OSH Program	Fall Prevention Programme
17	Program Implementation Cost (US$)	681,821

II.6. Benefit-Cost Ratio for the projects

Based on data provided by the five companies, the Lead Consultant from the Ministry of Manpower of Indonesia computed and derived the Benefit-Cost Ratios (BCRs) for each of the worksites as follows:

The BCRs derived for Worksites SG1 and SG5 were significantly high and low respectively, relative to the other three worksites. The Singapore team was allowed to peruse a copy of the BCR calculations to trace the reasons behind the wide variations.

After resolving for some data entry errors and after applying some additional assumptions that are consistent across all five companies to allow for a consistent quantification of benefits, an adjusted BCR comparison of the five companies is derived as follows:

It is observed that the BCR for Worksite SG1 has reduced from 3.11 to 1.38, while the BCR for Worksite SG5, has increased from 0.02 to 0.48. There were slight revisions to the BCRs for the other three worksites.

III. Discussion and Conclusion

The importance of this (and similar) research as a basis for improving occupational safety and health in the workplace.

Numerous studies have been conducted around the world to look into the importance of occupational health and safety, their related costs as well as the financial consequences of accidents in the workplace. Accidents in the construction industry have been found to impose substantial costs not just to workers but to employers and society too (Haslam, et al 2004[6]).

A study by the Singapore Workplace Safety And Health Institute, published in 2013, estimated the economic cost of work-related injuries and ill-health in Singapore to be S$10.45B for the year 2011, equivalent to 3.2% GDP. This amount can be further broken down as cost borne by workers (S$5.28B), by employers (S$2.31B) and by community (S$2.87B)[7]. A research of the construction industry in the UK also showed a strong positive correlation between the costs of accident prevention measures and the reduction of work-related accidents[8]. A study on implementing OHS measures at a Bangladeshi shipyard produced immediate benefits, including big drops in monthly injury rates as well as significant intangible and economic gains[9].

Studies such as the above as well as this current research are important to quantify the financial benefits to businesses that result from the effective implementation of good occupational safety and health programs. When businesses see the beneficial impact of good safety and health outcomes to their bottom line, they will factor reasonable costs to implement safety and health programs in their projects.

Data collection process (challenges faced)

The costs of accidents incurred by contractors on account of accidents are divided into three sections[10]. The first is the 'cost of construction health and safety measures' i.e. expenses invested directly by contractors in safety measures to prevent accidents. The second is 'direct costs', which is cost caused by accidents arising from the occurrence of accidents despite the fact that safety measures were in place. The third is the 'indirect costs' of accidents. All these costs contribute to the overall monetary costs of accidents.

6 Haslam, R.A. Hide, S.A., Gibb, A.G.F, Gyi, D. E., Pavitt, T, Atkinson, S. and Duff, R.A (2004). Contributing Factors in Construction Accidents. Journal Paper on Applied Ergonomics

7 WSH Institute Report. Economic Cost of Work-related Injuries and Ill-health in Singapore. 2013

8 Ikpe E, Hammond F, Proverbs D, Oloke D. Model predicting cost benefit analyses (cba) of accident prevention on construction projects. Int J. Saf Secur Eng. 2011;1(3):298–311.

9 Irene Thiede, Michael Thiede. Quantifying the costs and benefits of occupational health and safety interventions at a Bangladesh shipbuilding company. International Journal of Occupational and Environmental Health. 2015

10 Elias Ikpe, David Proverbs and Felix Hammond. A cost-benefit analysis (CBA) of construction health and safety management: A theoretical discussion. 2008

In this research, respondents to the questionnaire were asked to quantify the costs spent to implement an OSH program in a construction project. Such costs would usually be easily obtainable as they would be recorded in the companies' accounts.

The use of CBA to calculate maximum benefits is of fundamental importance to the construction industry. One method of calculating the benefits of reducing accident is that of estimating the current costs that will be averted if accidents are avoided. A reduction in costs of accidents can be directly translated into a benefit for contractors (Ikpe et al., 2007[11]). In this research project, the respondents were also asked to quantify the benefits from their implemented OSH program, in terms of the savings or the avoidance of costs that would usually be incurred following workplace accidents, for instance, medical costs, compensation costs, investigations costs, litigation costs as well as penalties imposed by regulators. These costs were much harder to quantity as they would not be recorded in any book if they were not spent.

One way to overcome this was to approximate the accidents that would have occurred, i.e. the likelihood of an accident, if not for the implementation of the OSH program. Dorman[12] classified safety costs, differentiating between financial and non-financial costs, between internal and external costs, between fixed and variable costs and between direct (or visible) and indirect (or invisible) costs. The former is fully and explicitly recorded in the accounting system, while the latter are not and, as a result, cannot be quantified without observation and case-by-case monitoring of accidents and occupational illnesses (or the use of approximations).

The use of "likelihood" of an accident does have its own disadvantages[13]. For example, in an activity that has 1,000 man-hours work and accident frequency rate of 0.002 (accident/work-hours), the accident likelihood will be calculated as 2 (accident frequency x exposure). This means that in a 1,000 man-hours of work, 2 occupational accidents will take place. However, occupational accidents are random events, and it would be wrong to give an exact number of accidents for a given activity.

Another disadvantage would arise even if it is able to approximate the number of accidents that can be avoided. For instance, it may be difficult to justify that the accidents were avoided due to the OSH program and not for any other reason.

One other challenge facing this research is that there was no quantification of indirect costs of accidents. Quantifying the value of accident reduction is difficult, requiring the quantification of both direct and indirect costs (e.g. pain suffered). In

11 Ikpe, E. Potts, K.F, Proverbs, D. and Oloke, D. (2007) Application of Cost-Benefit Analysis for effective health and safety management in the construction industry. Association for the Advancement of Cost Engineering (AACE), 51st Annual Conference, Nashville, Tennessee. USA

12 Dorman P. The Economics of Safety, Health, and Well-Being at Work: An Overview. In: Focus Program on Safe Work, International Labour Organisation. The Evergreen State College: Washington; 2000.

13 BİLİR and GÜRCANLI. A Method for Determination of Accident Probability in the Construction Industry. Teknik Dergi, 2018 8537-8561, Paper 511. 2018

an examination of the less quantifiable factors that contribute to accident related expenses, French estimated the costs of workplace injuries beyond medical and lost wages[14]. He used a willingness-to-pay model to assess pain and suffering costs incurred by injured workers in the American railroad industry. The study concluded that a complete estimate including pain and suffering is much higher than the medical and staffing costs alone.

One challenge faced by the Singapore project team was that many companies that were invited to participate in the research declined as they were afraid that the data provided would be scrutinized negatively and would result in the regulators following up on them with inspections or investigations at their workplaces. Therefore, companies would feel some resistance to participate and provide such data.

Furthermore, some companies may not keep detailed records of spending in OSH as such costs would usually be integrated with their operational costs. Private sector development and projects may not explicitly specify or require companies to include a sum that is reserved for OSH spending in their tender process and the costs for implementing OSH in the projects are assumed to be part of the tendered amount that the companies submit.

Companies may also not be consistent in their interpretation of some of the terms used in the questionnaire. For instance, the definition of incident, accident and a near miss seemed to overlap, e.g., a "near miss" could have been interpreted as an "incident" based on the definition given in the questionnaire. Furthermore, recordkeeping hygiene across the companies may also vary as not all companies would keep records of incidents that are not required to be reported to the authorities. A clearer and distinct definition of each term would be beneficial and more accurate for the study if such parameters were to be used in the research analysis.

During the process of data collection, four of the five companies were unable to quantify the benefits resulting from the implementation of the safety programme. They reflected that the improvement gained from the safety programmes were intangible and they did not have concrete basis or past reference to quantify the benefits meaningfully. Hence, the assessment of all the costs stated in this report may only be accurate to a certain extent, as there were costs that were not actually incurred by the companies, and can only be estimated based on their understanding of Singapore's legal system, health & medical systems, as well as their own companies' operations.

How findings can be used to help companies (and relevant stakeholders) in designing and implementing safety and health programs in the workplace

14 French MT. Estimating the full cost of workplace injuries. Am J Public Health. 1990;80(9):1118–9.

Huang et al.[15,16] showed, in an empirical study, that managers believed the main benefits of an effective safety program to be predominantly financial in nature[17], but failed to recognize increased productivity or reduced costs.

A study on safety cost management in construction companies in Spain showed that most companies have no information on the costs of risk-prevention measures or on those arising from accidents[18]. As a result, such companies are unable to include these variables in their occupational risk prevention policy. Intangible non-safety costs are frequently not recorded and are omitted from conventional accounting systems. Estimation of such costs usually relies on the hypothesis of a functional relationship between them and the presumed causative factors[19]. According to Gosellin[20], the intangible costs of accidents are those which cannot be easily estimated in terms of their economic impact, or are those for which we still lack reliable performance indicators to measure their effect on the company (such as loss of image, low employee morale, labour disputes or market loss).

Additional thoughts on findings of the research project

While CBA is generally considered a relevant tool for creating better and neutral results for decision-making, it has been criticised for two main reasons (Hwang, 201621):

- Monetary valuation: because there are no natural prices or monetary values for goods like human life, CBA approximates the price of non-market goods whose values are incommensurable (Ackerman & Heinzerling, 200222; Adler, 199823);
- Discounting: discounting future value to compare them with present value becomes controversial when it is applied to the monetary value of non-market goods, as it would encourage, in an extreme example, to adopt a program that saves one life today over a program that would save millions of lives in the future (Ackerman & Heinzerling, 2002; Clowney, 200624); furthermore, the choice of the most appropriate social discount rate has long been a contentious issue.

15 Huang YH, Leamon TB, Courtney TK, Chen PY, DeArmond S. Corporate financial decision-makers' perceptions of workplace safety. Accident, Analysis & Prevention 2007;39:767-75.

16 Huang YH, Leamon TB, Courtney TK, Chen PY, DeArmond, S. A comparison of workplace safety perceptions among financial decision-makers of medium- vs. large-size companies. Accident, Analysis & Prevention 2011;43:1-10.

17 Barretoa MM, Ribeiro SLO. Aircraft accident investigation: The decision-making in initial action scenario. Work: A Journal of Prevention, Assessment and Rehabilitation 2012;41:4931-5.

18 L´opez-Alonso, Ibarrondo-D´avila and Rubio. Safety cost management in construction companies: A proposal classification. Work 54 (2016) 617– 630, DOI:10.3233/WOR-162319, IOS Press

19 Requena Rodr´ıguez JM, Vera R´ıos S. Contabilidad interna (contabilidad de costes y de gesti´on). C´alculo, an´alisis y control de costes y resultados para la toma de decisiones. Ariel Barcelona; 2008.

20 Gosselin M. Analyse des avantages et des coˆuts de la sant´e et de la s´ecurit´e au travail en entreprise: D´eveloppement de l'outil d'analyse. Rapport de Recherche R-375. IRSST, Montr´eal; 2004.

Lessons learned from the BCRs collected

The BCRs for the five worksites ranged from 0.48 to 1.38, with an average of 0.75. Out of the five worksites, three had BCRs less than 1, thus showing that these worksites were unable to reap the "maximum benefits" from the chosen safety program. This is not surprising as these three companies were unable to quantify the benefits resulting from the implementation of the chosen safety program. Hence, this further proved that without complete and accurate data, BCR analysis would not be fruitful and meaningful.

1. Hwang, K. (2016). Cost-benefit analysis: its usage and critiques. Journal of Public Affairs, 16(1), 75–80.
2. Ackerman, F., & Heinzerling, L. (2002). Pricing the priceless: Cost-benefit analysis of environmental protection. University of Pennsylvania Law Review, 150(5), 1553–1584.
3. Adler, M. (1998). Incommensurability and cost-benefit analysis. University of Pennsylvania Law Review, 146(5), 1371–1418.
4. Clowney, S. (2006). Environmental Ethics and Cost-Benefit Analysis. Fordham Envtl. L. Rev., 18, 105.

Conclusions

The concept of Cost-Benefit Analysis (CBA) and computations of Benefit-Cost Ratios (BCRs), in theory can help companies see the importance and effectiveness of implementing good OSH programs. The challenge is to develop a model that contains harmonised ways to classify and quantify costs and benefits.

In Singapore, it is not uncommon for contractors to lump both construction and safety costs together. For instance, scaffolds and screen nettings used in construction projects are typically classify as construction costs and not safety costs. There are also certain costs which are mandatory by legislations in Singapore. For instance, the engagement of safety officers and auditors are compulsory in many construction projects, and these could also be classified as construction costs.

Furthermore, as was observed in the Singapore project, the ability to quantify the savings from a well-managed and an accident-free project is subjective and hypothetical. Savings from nil enforcement actions or loss time due to authority-imposed work stoppages may not be consistently factored. Without harmonising the cost-benefit quantifications, any assumption or parameter made by the contractors could easily be of different extremes which could skew the BCRs either way.

National Report

RESEARCH ON ECONOMIC JUSTIFICATION OF OCCUPATIONAL SAFETY AND HEALTH (OSH) IMPLEMENTATION IN THE CONSTRUCTION SECTOR

THAILAND

I. Introduction

According to the data from Social Security Office – Ministry of Labour during 2017 -2020, a total of 10.79 million of employed persons and a total of 407,010 of employers registered with the Social Security Office. Considering the statistics on occupational injuries and diseases in average, with following Table 1, it is shown that employees were still vulnerable to hazardous works and facing high risk of occupational injuries. Among the 10.79 million employees under the workmen's compensation coverage, there were 88,254 decided cases of occupational injuries and diseases, as classified by severity, composed of leave work < 3 days 60,333 cases or 68.36 %, leave work > 3 days 26,154 cases or 29.5 %, lost of organ 1,161 cases or 1.31%, disability 14 cases and death 591 cases or 0.02% respectively. Detailed statistics are shown in Table 1.

Table 1 Number of Occupational Injuries and Diseases: 2017–2020, as Classified by Severity

Year	Number of Employers	Number of Employees	Number of Occupational Injuries and Diseases					
			Deaths	Disability	Lost of organ	Leave work> 3 days	Leave work< 3 days	Total
2017	371,432	9,777,751	570	17	1,200	25,820	58,671	86,278
2018	396,394	10,537,238	568	13	1,226	25,303	59,187	86,297
2019	428,821	11,710,823	639	13	1,211	27,812	65,231	94,906
2020	431,392	11,153,697	588	14	1,005	25,682	58,244	85,533
4 Yrs Average	407,010	10,794,877	591	14	1,161	26,154	60,333	88,254

In 2017 - 2020, a total of employees and employers of construction business registered with the Social Security Office were 16,355 and 313,841. A total of 20,600 occupational injuries and diseases in construction business and 5,150 cases of each year in average.

Table 2 Number of Occupational Injuries and Diseases of Construction Business: 2017-2020, as Classified by Severity

Year	Number of Occupational Injuries and Diseases										
	Deaths	%	Disability	%	Lost of organ	%	Leave work> 3days	%	Leave work< 3days	%	Total
2017	57	1.34	6	0.14	33	0.77	1,149	27.0	3,011	70.75	4,256
2018	57	1.23	3	0.06	33	0.71	1,230	26.5	3,319	71.50	4,642
2019	92	1.47	3	0.05	31	0.49	1,589	25.4	4,542	72.59	6,257
2020	49	0.9	2	0.04	28	0.51	1,411	25.91	3,955	72.64	5,445
4 Yrs Average	64	1.24	4	0.07	31	0.60	1,345	26.11	3,707	71.98	5,150

As shown in Table 2, the number of occupational injuries and diseases in average, classifies by severity, for construction business consist of leave work < 3 days 3,707 cases, leave work > 3 days 1,345 cases, lost of organ 31 cases, disability 4 cases and death 64 cases respectively.

II. Results

II.1. Small Enterprise 1 (S1)

Small Enterprise 1, a private limited partnership, is small-size enterprise of construction business. Small Enterprise 1 is one of contractor in Mass Rapid Transit Project. There are 50 employees and safety personnel consisting of 1 safety officer, 3 safety supervisors and 1 secretary in the project. The project has an estimated construction budget of 400 million US dollars with the Small Enterprise 1's own source of funds for construction, with a total construction period of 2 years and 5 months. The total number of working days is 730 days. The Small Enterprise 1 has an operating budget of 9,091 US dollars on occupational safety and health throughout the project.

The essential programs of occupational safety and health have been implemented in the project with integration of works among relevant contractor. To achieve the intention in the reduction of work accidents and injuries in the project, with the following programs:

1. 5 S Activities (Seiri, Seiso, Seiso, Seiketsu, Shitsuke);
2. Toolbox Talk Activities;
3. Campaign: Safety at Height Level;
4. Safety Audits and Training.

According to the statistics of occupational hazards at the completion of the project, it was found that the number of near-miss per 1 million man-hours

were 20, and there were 15 first aid attempts. The number of incidents resulting in damaged machinery and equipment (more than US$ 100) per 1 million man-hours were 10 times. The number of incidents and injured workers per 1 million man-hours were 15 and 14 times, but no fatalities and lost working days. 242,425 US dollars in total work accident compensation.

The OSH program, which is considered for Cost-Benefit Analysis, is campaign of safety at height level. The objective of the campaign is to encourage safety awareness for working at height level on construction site and inspect proper condition of personnel protection equipment and uniform. The implementation costs incurred in achieving the campaign on "Safety at Height Level" comprising of procurement and maintenance of fall protection equipment US$ 610 and US$ 310 consequently. As a result of the program, the Small Enterprise 1 could save costs and gain potential benefits resulting from the program, with the following Table 3:

Table 3 List of costs saved and potential benefits resulting from the OSH program (S1)

Costs saved	Potential benefits
1. Medical Costs US$ 13,365 2. Equipment and Property US$ 1,212 3. Material and Products US$ 606 4. Law/Litigation US$ 606 5. Time Costs US$ 109,125 6. Temporary Staff US$ 1,305	1. Productivity improvement US$ 24,570 2. Saving on damaged products US$ 12,160/yr 3. Saving on materials used US$ 152/quarter 4. Saving on maintenance US$ 76/month 5. Staff commitment improvement US$ 120/yr

Benefit-Cost Ratio, derived from total benefits (US$207,576.89) and total costs (US$ 51,695.50), for the project is 4.015

II.2. Small Enterprise 2 (S2)

Small Enterprise 2, a private company limited, is small-size enterprise of construction business. Small Enterprise 2 is one of contractor in Mass Rapid Transit Project. There are 45 employees and safety personnel consisting of 1 safety officer, 3 safety supervisors and 1 secretary in the project. The project has an estimated construction budget of 350 million US dollars with the Small Enterprise 2's own source of funds for construction, with a total construction period of 2 years. The total number of working days is 730 days. The Small Enterprise 2 has an operating budget of 1,220 US dollars on occupational safety and health throughout the project.

The essential programs of occupational safety and health have been implemented in the project with integration of works among relevant contractor. To achieve the intention in the reduction of work accidents and injuries in the project, with the following programs:

1. 5 S Activities (Seiri, Seiso, Seiso, Seiketsu, Shitsuke);

2. Toolbox Talk Activities;
3. Campaign: Safety at Height Level;
4. Safety Audits and Training.

According to the statistics of occupational hazards at the completion of the project, it was found that the number of near-miss per 1 million man-hours were 15, and there were 10 first aid attempts. The number of incidents resulting in damaged machinery and equipment (more than US$ 100) per 1 million man-hours were 8 times. The number of incidents per 1 million man-hours were 2 times, but no workers injured, fatalities and lost working days. 181,820 US dollars in total work accident compensation.

The OSH program, which is considered for Cost-Benefit Analysis, is campaign of safety at height level. The objective of the campaign is to encourage safety awareness for working at height level on construction site and inspect proper condition of personnel protection equipment and uniform. The implementation costs incurred in achieving the campaign on "Safety at Height Level" comprising of procurement and maintenance of fall protection equipment US$ 910 and US$ 610 consequently. As a result of the program, the Small Enterprise 2 could save costs and gain potential benefits resulting from the program, with the following Table 4:

Table 4 List of costs saved and potential benefits resulting from the OSH program (S2)

Costs saved	Potential benefits
1. Medical Costs US$ 11,175 2. Equipment and Property US$ 1,212 3. Material and Products US$ 606 4. Law/Litigation US$ 606 5. Time Costs US$ 40,050 6. Temporary Staff US$ 920	1. Productivity improvement US$ 24,570 2. Saving on damaged products US$ 12,160/yr 3. Saving on materials used US$ 152/quarter 4. Saving on maintenance US$ 76/month 5. Staff commitment improvement US$ 120/yr

Benefit-Cost Ratio, derived from total benefits (US$ 112,420.97) and total costs (US$ 49,544.02), for the project is 2.269

II.3. Medium Enterprise 1 (M1)

Medium Enterprise 1, a private company limited, is medium-size enterprise of construction business. Medium Enterprise 1 is one of contractor in Mass Rapid Transit Project. There are 200 employees and safety personnel consisting of 2 safety officers, 10 safety supervisors and 2 secretaries on site and 1 safety manager, 3 safety supervisors, 4 senior safety officers and 1 secretary in main office. The project has an estimated construction budget of 17.79 million US dollars with the Medium Enterprise 1's own source of funds for construction, with a total construction period of 4 years. The total number of working days

is 1,000 days. The Medium Enterprise 2 has an operating budget of 15,000 US dollars on occupational safety and health throughout the project.

The essential programs of occupational safety and health have been implemented in the project with integration of works among relevant contractor. To achieve the intention in the reduction of work accidents and injuries in the project, with the following programs:

1. Toolbox Talk Activities;
2. KYT
3. Safety Patrol;
4. Safety Excellence Award.

According to the statistics of occupational hazards at the completion of the project, it was found that the number of near-miss per 1 million man-hours were 5, and there were 2 first aid attempts. The number of incidents per 1 million man-hours were 2 times. The number of workers injured per 1 million man-hours were 2 times. 2 lost working days due to incidents, but no machinery and equipment damaged, fatality and compensation due to accident.

The OSH program, which is considered for Cost-Benefit Analysis, is "KYT" program. The objective of the program is to increase encourage safety awareness workers, subcontractors and suppliers in the construction site. The implementation costs incurred in achieving the program is US$ 186,000. As a result of the program, the Medium Enterprise 1 could save costs and gain potential benefits resulting from the OSH program, with the following Table 5:

Table 5 List of costs saved and potential benefits resulting from the OSH program (M1)

Costs saved	Potential benefits
1. Medical Costs US$ 143,940 2. Equipment and Property US$ 600 3. Material and Products US$ 300 4. Law/Litigation US$ 300 5. Time Costs US$ 52,560 6. Temporary Staff US$ 13,860	1. Productivity improvement US$ 81,900 2. Saving on damaged products US$ 13,680/yr 3. Saving on materials used US$ 152/quarter 4. Saving on maintenance US$ 76/month 5. Staff commitment improvement US$ 120/yr

Benefit-Cost Ratio, derived from total benefits (US$ 424,784.94) and total costs (US$ 774,650.90), for the project is 0.548

II.4. Medium Enterprise 2 (M2)

Medium Enterprise 2, a private company limited, is medium-size enterprise of construction business. Medium Enterprise 2 is one contractor of housing/condominium project. There are 195 employees and safety personnel consisting of 3 safety officers and 1 safety supervisor on site and 2 safety manager and 1

senior safety officer in main office. The project has an estimated construction budget of 8,968,611 US dollars with the Medium Enterprise 2's own source of funds for construction, with a total construction period of 4 years. The total number of working days is 1,344 days. The Medium Enterprise 2 has an operating budget of 95,665 US dollars on occupational safety and health throughout the project.

The essential programs of occupational safety and health have been implemented in the project with integration of works among relevant contractor. To achieve the intention in the reduction of work accidents and injuries in the project, with the following programs:

1. Safety Talk;
2. Safety Training;
3. Safety Patrol;
4. Safety Audit.

According to the statistics of occupational hazards at the completion of the project, it was found that there were 13 first aid attempts. The number of incidents resulting in damaged machinery and equipment (more than US$ 100) per 1 million man-hours were 2 times. The number of incidents per 1 million man-hours were 2 times. The number of injured workers per 1 million man-hours was 1 time. 3 lost working days due to incidents, but no near-miss, fatality and compensation due to accident.

The OSH program, which is considered for Cost-Benefit Analysis, is "Safety Talk" program. The objective of the program is to increase encourage safety awareness workers, subcontractors and suppliers in the construction site. The implementation costs incurred in achieving the program is US$ 386,450. As a result of the program, the Medium Enterprise 2 could save costs and gain potential benefits resulting from the OSH program, with the following Table 6:

Table 6 List of costs saved and potential benefits resulting from the OSH program (M2)

Costs saved	Potential benefits
1. Medical Costs US$ 118,118 2. Equipment and Property US$ 600 3. Material and Products US$ 300 4. Law/Litigation US$ 300 5. Time Costs US$ 39,858 6. Temporary Staff US$ 14,164	1. Productivity improvement US$ 6,750 2. Saving on damaged products US$ 13,680/yr 3. Saving on materials used US$ 152/quarter 4. Saving on maintenance US$ 76/month 5. Staff commitment improvement US$ 120/yr

Benefit-Cost Ratio, derived from total benefits (US$ 314,880.43) and total costs (US$ 631,146.00), for the project is 0.498

II.5. Large Enterprise 1 (L1)

Large Enterprise 1, a private company limited, is large-size enterprise of construction business. Large Enterprise 1 is one contractor of housing/ condominium project. There are 520 employees and safety personnel consisting of 1 safety officer and 4 safety supervisors on site and 1 safety officer in main office. The project has an estimated construction budget of 31,401,896 US dollars with the Large Enterprise 1's own source of funds for construction, with a total construction period of 3 years and 4 months. The total number of working days is 1,230 days. The Large Enterprise 1 has an operating budget of 43,000 US dollars on occupational safety and health throughout the project.

The essential programs of occupational safety and health have been implemented in the project with integration of works among relevant contractor. To achieve the intention in the reduction of work accidents and injuries in the project, with the following programs:

1. Safety Talk;
2. Safety Awareness Training;
3. Safety Audit.

According to the statistics of occupational hazards at the completion of the project, it was found that the number of near-miss per 1 million man-hours were 5, there was 1 first aid attempts. The number of incidents resulting in damaged machinery and equipment (more than US$ 100) per 1 million man-hours was 1 time. The number of incidents per 1 million man-hours was 1 time. The number of injured workers per 1 million man-hours was 1 time. 1 lost working day due to incident, but no fatality and compensation due to accident.

The OSH program, which is considered for Cost-Benefit Analysis, is "Safety Awareness Training" program. The objective of the program is to increase encourage safety awareness workers, subcontractors and suppliers in the construction site. The implementation costs incurred in achieving the program is US$ 374,500. As a result of the program, the Large Enterprise 1 could save costs and gain potential benefits resulting from the OSH program, with the following Table 7:

Table 7 List of costs saved and potential benefits resulting from the OSH program (L1)

Costs saved	Potential benefits
1. Medical Costs US$ 292,050 2. Equipment and Property US$ 1,212 3. Material and Products US$ 606 4. Law/Litigation US$ 606 5. Time Costs US$ 35,550 6. Temporary Staff US$ 5,250	1. Productivity improvement US$ 20,250 2. Saving on damaged products US$ 13,680/yr 3. Saving on materials used US$ 152/quarter 4. Saving on maintenance US$ 76/month 5. Staff commitment improvement US$ 600/yr

Benefit-Cost Ratio, derived from total benefits (US$ 408,387.56) and total costs (US$ 479,313.70), for the project is 0.852

II.6. Large Enterprise 2 (L2)

Large Enterprise 2, a private public company limited, is large-size enterprise of construction business. Large Enterprise 2 is contractor of Mass Rapid Transit Project. There are 2,500 employees and safety personnel consisting of 4 safety officers, 4 safety supervisors and 1 secretary on site and 1 safety manager, 1 senior safety officer and 1 secretary in main office. The Large Project 2 has an estimated construction budget of 356,233,333 US dollars with the Large Enterprise 2's own source of funds for construction, with a total construction period of 5 years. The total number of working days is 1,890 days. The Large Enterprise 2 has an operating budget of 840,000 US dollars on occupational safety and health throughout the project.

The essential programs of occupational safety and health have been implemented in the project with integration of works among relevant contractor. To achieve the intention in the reduction of work accidents and injuries in the project, with the following programs:

1. Safety Talk;
2. Safety Awareness Training;
3. Safety Audit;
4. Site Inspection.

According to the statistics of occupational hazards at the completion of the project, it was found that there were 30 first aid attempts. The number of incidents resulting in damaged machinery and equipment (more than US$ 100) per 1 million man-hours were 2 times. The number of incidents per 1 million man-hours were 4 times. The number of injured workers per 1 million man-hours were 3 times. 2 lost working day due to incidents, but no near-miss, fatality and compensation due to accident.

The OSH program, which is considered for Cost-Benefit Analysis, is "Safety Awareness Training" program. The objective of the program is to increase

encourage safety awareness workers, subcontractors and suppliers in the construction site. The implementation costs incurred in achieving the program is US$ 775,100. As a result of the program, the Large Enterprise 2 could save costs and gain potential benefits resulting from the OSH program, with the following Table 8:

Table 8 List of costs saved and potential benefits resulting from the OSH program (L2)

Costs saved	Potential benefits
1. Medical Costs US$ 1,298,000 2. Equipment and Property US$ 1,212 3. Material and Products US$ 606 4. Law/Litigation US$ 606 5. Time Costs US$ 5,190,000 6. Temporary Staff US$ 154,300	1. Productivity improvement US$ 273,000 2. Saving on damaged products US$ 13,680/yr 3. Saving on materials used US$ 152/quarter 4. Saving on maintenance US$ 76/month 5. Staff commitment improvement US$ 600/yr

Benefit-Cost Ratio, derived from total benefits (US$ 3,913,477.44) and total costs (US$1,250,947.91), for the project is 3.128

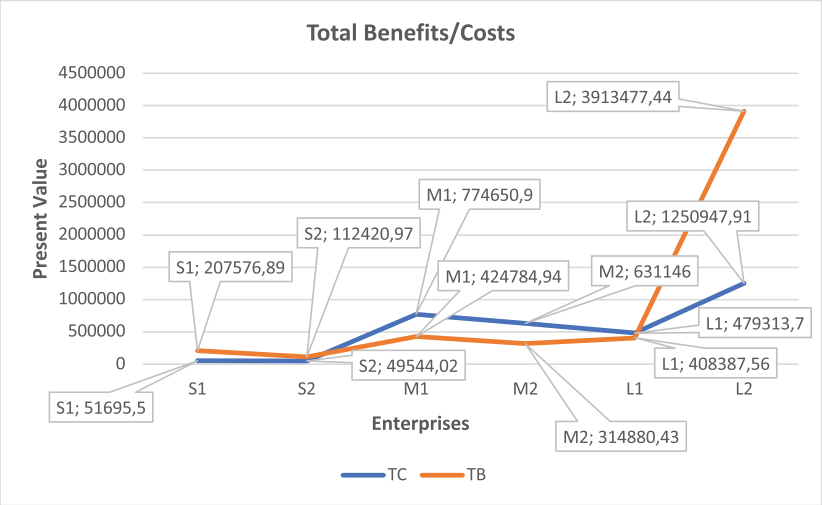
III. Discussion and Conclusion

Cost-benefit analysis is an important tool that the enterprises will be able to use to help them make the right decision in order to invest the OSH program in the construction site.The advantages of cost-benefit analysis make the enterprises not only understand implementation cost including procurement, installation, training, operation, maintenance, program promotion and other expense but also predict the costs saved and potential benefit resulting from the OSH program. Which lead them to clearly see the correction between cost and benefit and then make decisions in a structured manner.

This research collected the cost-benefit of safety and health programs from 6 enterprises consisting of 2 small-size, 2 medium-size and 2 large-size enterprises. It can be seen that a total of benefits are higher than a total of costs in Small Enterprise 1 (S1), Small Enterprise 2 (S2) and Large Enterprise 2 (L2). However, a total of benefits

are less than a total of costs in Medium Enterprise 1 (M1), Medium Enterprise 2 (M2) and Large Enterprise 1 (L1), with the following Figure 1:

Figure 1 Total Benefits and Costs of Six Enterprises



Data collection process (challenges faced)

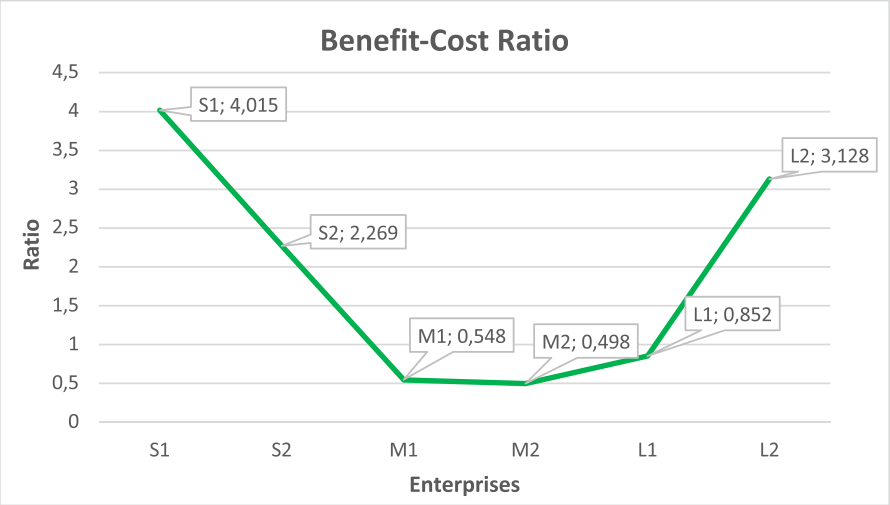
There were a few challenges of data collection in the research, as follow:

1. Most enterprises completed in the colleting the implementation costs, but some have lack of collecting data about the cost saved and potential benefit;
2. The enterprises have a variety of ways to collect data and are inconsistent with the data required by the questionnaire.

As Figure 2 shown, there were Cost-Benefit Ratio (BCR) of 4.015 in Small Enterprise 1 (S1), 2.269 in Small Enterprise 2 (S2) and 3.128 in Large Enterprise 2 (L2), which are larger than 1. It means that the OSH programs are profitable. Medium Enterprise

1 (M1), Medium Enterprise 2 (M2) and Large Enterprise 1 (L1) are less than 1, which mean the OSH programs should not be considered.

Figure 2 Benefit-Cost Ratio of Six Enterprises



Lessons learned from the BCRs collected

Due to a lack of collecting data about the cost saved and potential benefit in some enterprises, therefore, the research adopted the average of the costs saved and potential benefits of six enterprises in order to calculate BCRs of the study.

According to the CBA framework, the enterprises will be able to provide strategics for the sound management of health and safety at the construction site. The decision maker clearly sees the correction between cost and benefit, evaluate the outcomes of each program and make decisions in a more structured manner.

Conclusions

In order to achieve a reduction of injuries and diseases in the construction site, the enterprises provide strategics for management of health and safety at the construction site. However, the enterprises must understand the relationship between OSH programs and productivity and economics performances. This research collected the cost-benefit of safety and health programs from 6 enterprises consisting of 2 small-size, 2 medium-size and 2 large-size enterprises. We found that 3 enterprise's OSH programs are profitable, but other enterprises are undesirable. The highest of CBR is 4.015 in Small Enterprise, and the lowest is 0.498 in Medium Enterprise. This will encourage the enterprises to understand potential improvement and measure the difference costs and benefits and make decisions in a more structured manner on their own programs.

National Report

RESEARCH ON ECONOMIC JUSTIFICATION OF OCCUPATIONAL SAFETY AND HEALTH (OSH) IMPLEMENTATION IN THE CONSTRUCTION SECTOR

VIET NAM

I. Introduction

Description of the construction sector in Viet Nam; number of enterprises and workforce

Viet Nam's construction industry has been the best performing in the Asia Pacific region, having had the highest revenue growth rate in recent years. As an important pillar of the Vietnamese economy, the construction sector accounted for an increasing contribution to the gross domestic product while being one of the largest employers in Viet Nam. At the same time, it has been among industries that attracted the most foreign direct investment (FDI) in the past years. Despite the impact of the COVID-19 pandemic, this sector is forecast to continue growing alongside Viet Nam's rapid economic expansion.

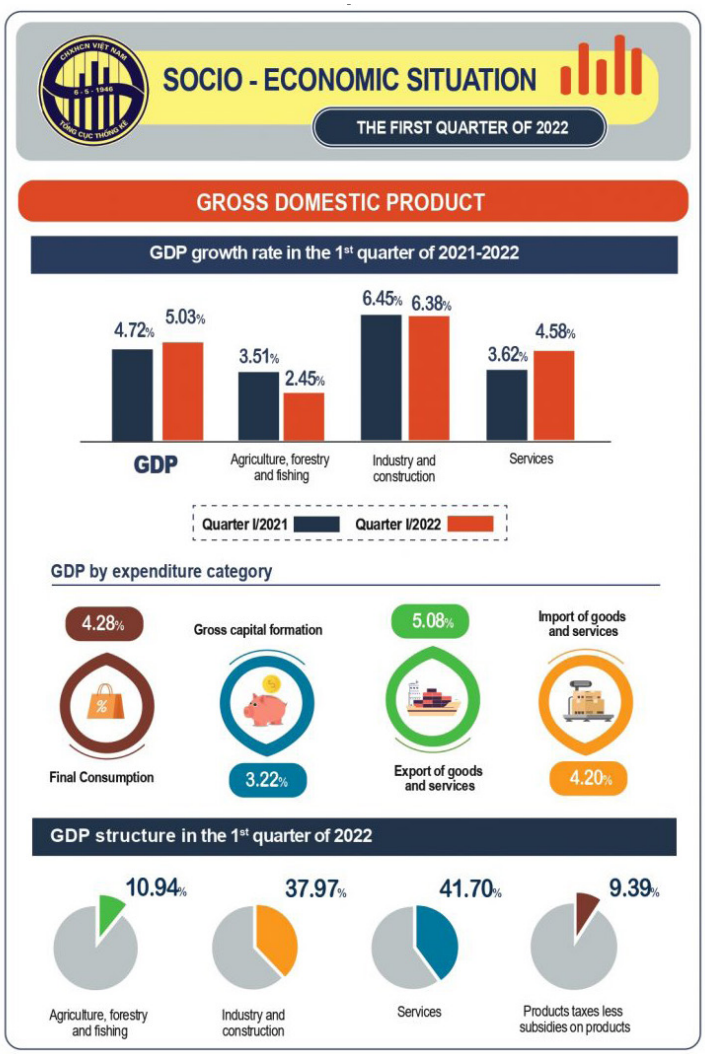
According to 2021 Economic Census:

- In terms of economic sector, the industry and construction sector accounts for the second largest proportion in terms of the number of units and employees (after the service sector). Of the total number of surveyed units, the industry and construction sector has 1.1 million units, accounting for 18.0% (in 2016 it was 19.0%). Regarding the number of employees, the industry and construction sector was 11.4 million people, accounting for 44.8%, up 0.8%.
- In the period 2016-2019, the number of enterprises and the number of employees increased rapidly year by year and tend to slow down in 2020 due to the impact of the Covid-19 pandemic.
- Industry and construction enterprises were 211.5 thousand enterprises, accounting for 30.9% of the total number of enterprises, an increase of 0.9% compared to 2019 and an increase of 44.5% compared to 2016.
- Employees in industrial and construction enterprises accounted for the highest proportion with 9.3 million employees, accounting for 63.4% of the total number of employees in enterprises, down 3.1% compared to the total number of employees in 2019 and up 2.3% compared to 2016.

Fig. 1.1. Industrial and construction sector in 2021 GDP structure

Regarding the economic structure in 2021, the industry and construction accounted for 37.86%. By economic sector in this year, there were 31.2 thousand enterprises in the industry and construction sector, decreased by 22.4% compared to 2020.

Fig. 1.2. GDP structure in the first quarter of 2022



Gross domestic product (GDP) in the first quarter of 2022 was estimated to increase by 5.03% over the same period last year, higher than the growth rate of 4.72% in the first quarter of 2021 and 3.66% in the first quarter of 2020 but still lower than the growth rate of 6.85% in the first quarter of 2019. Of which, the industry and construction sector increased by 6.38%, contributing 51.08%.

National statistics with respect to incidents and the associated death, injury, or ill health problems

According to Ministry of Labour, Invalids and Social Affairs (MOLISA)'s annual report on occupational accidents from 2013 to 2021, occupational accidents in the construction sector always rank first in terms of total number of fatal accidents and total number of deaths for 6 consecutive years from 2013 to 2018. The number of occupational accidents has decreased in recent years, especially in 2021, perhaps due to the impact of COVID-19 pandemic leading to social distancing and lockdowns.

Statistics on the percentage of fatal occupational accidents in the construction sector by year (2013 – 2021)

Year	Statistics of percentages for the construction sector	Ranking the production and business sectors with the most fatal occupational accidents	
		Total number of fatal occupational accidents	Total number of deaths
2021	Accounted for 9.73% of the total number of fatal occupational accidents and 10.26% of the total number of deaths	4th	3rd
2020	Accounted for 15.60% of the total number of fatal occupational accidents and 16.52% of the total number of deaths	2nd	2nd
2019	Accounted for 17.12% of the total number of fatal occupational accidents and 17.80% of the total number of deaths	2nd	2nd
2018	Accounted for 15.79% of the total number of fatal occupational accidents and 15.57% of the total number of deaths	1st	1st
2017	Accounted for 20.80% of the total number of fatal occupational accidents and 19.70% of the total number of deaths	1st	1st
2016	Accounted for 23.80% of the total number of fatal occupational accidents and 24.50% of the total number of deaths	1st	1st
2015	Accounted for 35.20% of the total number of fatal occupational accidents and 37.90% of the total number of deaths	1st	1st
2014	Accounted for 33.10% of the total number of fatal occupational accidents and 33.90% of the total number of deaths	1st	1st
2013	Accounted for 28.60% of the total number of fatal occupational accidents and 26.50% of the total number of deaths	1st	1st

Study objective

This research aimed at conducting a systematic approach in determining the benefit of OSH programs in the construction sector from an economic perspective, with data to be collected from all ASEAN Member States. Through this project, it is expected that we will gain knowledge and experience on how economic rationale can be employed to justify the implementation of OSH programs in the workplace. This understanding can be used further in persuading and motivating the management of construction enterprises to carefully evaluate their OSH programs. From this research, each enterprise can also learn how to carefully design OSH programs that will reduce OSH risks (give benefit for the workers), while satisfying the economic perspective (effective cost).

II. Results

II.1. Site 1: Small Project #1

Site 1 was a small-sized project located in Hanoi which is the capital city of Viet Nam and also the second largest city in Viet Nam, with the contractor of having less than 100 workers.

Industry which this project is classified in : Commercial (Hotel)

Project contract value (US$) : 3,281,315.78

Project duration (years, months) : 12 months

Details of Site 1:

Table 2.1. Details of Site 1

No	Question	Response
1	Number of working days in this project	204
2	Typical number of the workforce (including contractors)	80
3	Total amount invested by the company for OSH programs for this project (US$)	36,254.75
4	Number of near-miss per 1 million man-hours	2
5	Number of first aid per 1 million man-hours	0
6	Number of incidents resulting in damaged equipment/ property (more than US$100) per 1 million man-hours	0
7	Number of incidents per 1 million man-hours	0
8	Number of injured workers per 1 million man-hours	0
9	Number of fatalities per 1 million man-hours	0
10	LTIFR (*Lost Time Injury Frequency Rate*)	0
11	Working days lost due to incidents	0
12	Compensation paid due to accidents (US$)	0
13	Number of safety audits for the project	20
14	Number of safety training for the project	80

OSH Programs: Training on OSH, fire prevention & fighting and rescue.

Benefit-Cost Ratio for this Project: 7.710. For more details, see Table 2.9.2 below.

II.2. Site 2: Small Project #2

Site 2 was a small-sized project located in Hanoi, with the contractor of having less than 100 workers.

Industry which this project is classified in : Housing (high-rise apartment building)

Project contract value (US$) : 6,749,688.52

Project duration (years, months) : 12 months

Details of Site 2:

Table 2.2. Details of Site 2

No	Question	Response
1	Number of working days in this project	345
2	Typical number of the workforce (including contractors)	125
3	Total amount invested by the company for OSH programs for this project (US$)	82,026.48
4	Number of near-miss per 1 million man-hours	2
5	Number of first aid per 1 million man-hours	0
6	Number of incidents resulting in damaged equipment/ property (more than US$100) per 1 million man-hours	0
7	Number of incidents per 1 million man-hours	0
8	Number of injured workers per 1 million man-hours	0
9	Number of fatalities per 1 million man-hours	0
10	LTIFR (*Lost Time Injury Frequency Rate*)	0
11	Working days lost due to incidents	0
12	Compensation paid due to accidents (US$)	0
13	Number of safety audits for the project	52
14	Number of safety training for the project	208

OSH Programs: Responding to the Action Month on OSH and the Workers' Month 2022 launched by the Government of Viet Nam.

Benefit-Cost Ratio for this Project: 3.799. For more details, see Table 2.9.2 below.

II.3. Site 3: Medium Project #1

Site 3 was a medium-sized project located in Hanoi, with the contractor of having less than 200 workers.

Industry which this project is classified in : Commercial (complex of trade centers, offices and hotel apartments)

Project contract value (US$) : 13,253,523.00

Project duration (years, months) : 20 months

Details of Site 3:

Table 2.3. Details of Site 3

No	Question	Response
1	Number of working days in this project	660
2	Typical number of the workforce (including contractors)	350
3	Total amount invested by the company for OSH programs for this project (US$)	115,925.76
4	Number of near-miss per 1 million man-hours	1
5	Number of first aid per 1 million man-hours	8
6	Number of incidents resulting in damaged equipment/ property (more than US$100) per 1 million man-hours	12
7	Number of incidents per 1 million man-hours	
8	Number of injured workers per 1 million man-hours	4
9	Number of fatalities per 1 million man-hours	0
10	LTIFR (*Lost Time Injury Frequency Rate*)	6
11	Working days lost due to incidents	6
12	Compensation paid due to accidents (US$)	0
13	Number of safety audits for the project	Daily
14	Number of safety training for the project	2 times per week

OSH Programs:

1. Provide PPE for workers
2. Toolbox meeting (2 sessions per week)
3. General cleaning “Green Saturday” (every Saturday)
4. Electrical safety training
5. Training on working at height
6. Responding to the Action Month on occupational safety and health and the Workers’ Month 2022 launched by the Government of Viet Nam.

Benefit-Cost Ratio for this Project: 2.732. For more details, see Table 2.9.2 below.

II.4. Site 4: Medium Project #2

Site 4 was a medium-sized project located in Hanoi, with the contractor of having less than 200 workers.

Industry which this project is classified in : Housing

Project contract value (US$) : 8,550,661.64

Project duration (years, months) : 6 months

Details of Site 4:

Table 2.4. Details of Site 4

No	Question	Response
1	Number of working days in this project	200
2	Typical number of the workforce (including contractors)	400
3	Total amount invested by the company for OSH programs for this project (US$)	49,542.52
4	Number of near-miss per 1 million man-hours	2
5	Number of first aid per 1 million man-hours	0
6	Number of incidents resulting in damaged equipment/ property (more than US$100) per 1 million man-hours	0
7	Number of incidents per 1 million man-hours	0
8	Number of injured workers per 1 million man-hours	0
9	Number of fatalities per 1 million man-hours	0
10	LTIFR (*Lost Time Injury Frequency Rate*)	0
11	Working days lost due to incidents	0
12	Compensation paid due to accidents (US$)	0
13	Number of safety audits for the project	24
14	Number of safety training for the project	72

OSH Programs:

1. Strengthening measures to reduce risks on OSH, improve working conditions, adapt safely, flexibly and effectively control the COVID-19 pandemic at the workplace.
2. Responding to the Action Month on occupational safety and health and the Workers' Month 2022 launched by the Government of Viet Nam.

Benefit-Cost Ratio for this Project: 5.630. For more details, see Table 2.9.2 below.

II.5. Site 5: Large Project #1

Site 5 was a large-sized project located in Ho Chi Minh City which is the largest city in Viet Nam, with the contractor of having more than 200 workers.

Industry which this project is classified in : Commercial

Project contract value (USD$) : 21,376,650

Project duration (years, months) : 24 months

Details of Site 5:

Table 2.5. Details of Site 5

No	Question	Response
1	Number of working days in this project	600
2	Typical number of the workforce (including contractors)	1,000
3	Total amount invested by the company for OSH programs for this project (US$)	42,753.30
4	Number of near-miss per 1 million man-hours	5
5	Number of first aid per 1 million man-hours	3
6	Number of incidents resulting in damaged equipment/ property (more than US$100) per 1 million man-hours	5
7	Number of incidents per 1 million man-hours	5
8	Number of injured workers per 1 million man-hours	3
9	Number of fatalities per 1 million man-hours	0
10	LTIFR (*Lost Time Injury Frequency Rate*)	0.625
11	Working days lost due to incidents	3
12	Compensation paid due to accidents (US$)	0
13	Number of safety audits for the project	7
14	Number of safety training for the project	7

OSH Programs:

1. Strictly inspect and maintain machinery and equipment at the site.
2. Organize input and periodical internal training for each new team and worker.
3. Contact medical facilities with periodic health check and occupational disease examination.
4. Inspect electrical equipment monthly.
5. Organize weekly Covid-19 testing.

Benefit-Cost Ratio for this Project: 1.044. For more details, see Table 2.9.2 below.

II.6. Site 6: Large Project #2

Site 6 was a large-sized project located in Ho Chi Minh City, with the contractor of having more than 200 workers.

Industry which this project is classified in : Housing

Project contract value (US$) : 26,069,535.43

Project duration (years, months) : 24 months

Details of Site 6:

Table 2.6. Details of Site 6

No	Question	Response
1	Number of working days in this project	592
2	Typical number of the workforce (including contractors)	1,840
3	Total amount invested by the company for OSH programs for this project (US$)	345,005.69
4	Number of near-miss per 1 million man-hours	0
5	Number of first aid per 1 million man-hours	0
6	Number of incidents resulting in damaged equipment/ property (more than US$100) per 1 million man-hours	0
7	Number of incidents per 1 million man-hours	0
8	Number of injured workers per 1 million man-hours	0
9	Number of fatalities per 1 million man-hours	0
10	LTIFR (*Lost Time Injury Frequency Rate*)	0
11	Working days lost due to incidents	0
12	Compensation paid due to accidents (US$)	0
13	Number of safety audits for the project	23
14	Number of safety training for the project	72

OSH Programs:

1. Training on OSH according to Decree No. 44/2016/ND-CP issued by the Government of Viet Nam.
2. Training on safe operation of lifting equipment.
3. Training in the use of fire fighting equipment and fire prevention.

Benefit-Cost Ratio for this Project: The enterprise can't calculate the estimated total cost saved (costs avoided/saved resulting from the OSH programs) and the estimated potential benefits. So BCR can't be calculated.

II.7. Site 7: Large Project #3

Site 7 was a large-sized project located in Ho Chi Minh City, with the contractor of having more than 200 workers.

Industry which this project is classified in : Housing

Project contract value (US$) : 32,321,494.80

Project duration (years, months) : 22 months

Details of Site 7:

Table 2.7. Details of Site 7

No	Question	Response
1	Number of working days in this project	660
2	Typical number of the workforce (including contractors)	1,980
3	Total amount invested by the company for OSH programs for this project (US$)	364,514.64
4	Number of near-miss per 1 million man-hours	0
5	Number of first aid per 1 million man-hours	0
6	Number of incidents resulting in damaged equipment/ property (more than US$100) per 1 million man-hours	0
7	Number of incidents per 1 million man-hours	0
8	Number of injured workers per 1 million man-hours	0
9	Number of fatalities per 1 million man-hours	0
10	LTIFR (*Lost Time Injury Frequency Rate*)	0
11	Working days lost due to incidents	0
12	Compensation paid due to accidents (US$)	0
13	Number of safety audits for the project	84
14	Number of safety training for the project	80

OSH Programs:

1. Training on OSH (use PPE, working at height, electrical safety, etc.)
2. Training on fire prevention & fighting and rescue
3. Propaganda to keep the environment clean.

Benefit-Cost Ratio for this Project: The enterprise can't calculate the estimated total cost saved (costs avoided/saved resulting from the OSH programs) and the estimated potential benefits. So BCR can't be calculated.

II.8. Site 8: Large Project #4

Site 8 was a large-sized project located in Hanoi, with the contractor of having more than 200 workers.

Industry which this project is classified in : Complex of commercial and residential buildings

Project contract value ($) : 55,579,290.00

Project duration (years, months) : 28 months

Details of Site 8:

Table 2.8. Details of Site 8

No	Question	Response
1	Number of working days in this project	812
2	Typical number of the workforce (including contractors)	5,292
3	Total amount invested by the company for OSH programs for this project (US$)	228,559.14
4	Number of near-miss per 1 million man-hours	2.4
5	Number of first aid per 1 million man-hours	2.9
6	Number of incidents resulting in damaged equipment/ property (more than US$100) per 1 million man-hours	0
7	Number of incidents per 1 million man-hours	0
8	Number of injured workers per 1 million man-hours	8
9	Number of fatalities per 1 million man-hours	0
10	LTIFR (*Lost Time Injury Frequency Rate*)	17.9
11	Working days lost due to incidents	2.5
12	Compensation paid due to accidents (US$)	12
13	Number of safety audits for the project	165
14	Number of safety training for the project	8

OSH Programs: Provide PPE for workers.

Benefit-Cost Ratio for this Project: The enterprise can't calculate the estimated total cost saved (costs avoided/saved resulting from the OSH programs) and the estimated potential benefits. So BCR can't be calculated.

II.9. Ratios

Table 2.9.1 Ratio of total amount invested for OSH programs to project contract value

Ratio of total amount invested for OSH programs to project contract value:

	Site 1	Site 2	Site 3	Site 4	Site 5	Site 6	Site 7	Site 8
Project contract value, *US$* (V)	3,281,315.78	6,749,688.52	13,253,523.00	8,550,661.64	21,376,650	26,069,535.43	32,321,494.80	55,579,290.00
Total amount invested for OSH programs, *US$* (I)	36,254.75	82,026.48	115,925.76	49,542.52	42,753.30	345,005.69	364,514.64	228,559.14
Ratio, % (I/V)*100	1.105	1.215	0.874	0.579	0.200	1.323	1.128	0.411

Table 2.9.2 Benefit-cost ratio (BCR)

Benefit-cost ratio (BCR):

	Site 1	Site 2	Site 3	Site 4	Site 5	Site 6	Site 7	Site 8
Total benefits, *US$* (B)	279,521.08	311,586.05	316,716.45	278,922.53	44,655.82	undefined	undefined	undefined
Total costs, *US$* (C)	36,254.75	82,026.48	115,925.76	49,542.52	42,753.30	345,005.69	364,514.64	228,559.14
BCR (B/C)	7.710	3.799	2.732	5.630	1.044	undefined	undefined	undefined

III. Discussion and Conclusion

a. *The importance of this (and similar) research as a basis for improving occupational safety and health in the workplace.*

This study was the first of its kind conducted, perhaps in Viet Nam. This study is very important to ensure that every OSH program is "value for money". It is also important tool to measure the OSH program has achieved its objectives. This study also highlighted the ratio of costs spend for OSH to the overall cost of the project. The OSH programs included in this analysis are selected few that the contractors have data on cost spent for the OSH programs and their perceived benefits. There are other OSH programs carried out by contractors in their construction sites but not included in this study, which may also contributed to the overall effective safety and health management.

b. *Data collection process (challenges faced)*

- Data gathering for this project was facilitated by Viet Nam National Institute of Occupational Safety and Health (VNNIOSH) through its connection with Viet Nam National Union of Building Workers. The requirement for financial and safety data made it difficult for many enterprises to participate readily without the express approval of top management. The enterprises had to be assured that they will remain anonymous because the data they share may be used against them in the end. Many enterprises that were invited to participate in the research declined as they were afraid that the data provided would be scrutinized negatively and would result in the regulators following up on them with inspections or investigations at their workplaces. Therefore, enterprises would feel some resistance to participate and provide such data. Some other enterprises did not provide information about the monthly wage of their safety and health personnel for the reason that personal information is confidential.
- The enterprises have a variety of ways to collect data and are inconsistent with the data required by the questionnaire.
- Details on the cost to implement the OSH programs were not well recorded, and the benefits gained were also difficult to estimate. This was caused by the unclear objectives of the OSH programs was conducted. In addition, the effectiveness of the OSH programs was also not assessed after the programs were completed. The benefits and cost avoided one program were difficult to be separated or differentiated as the benefits and cost avoided were viewed as the results of OSH programs as a whole.
- It is difficult to fill in data related to the estimated costs that can be avoided due to the lack of data from enterprises. Most enterprises completed in collecting the implementation costs, but some have lack of collecting data about the cost saved and potential benefit.

c. *Lessons learned from the BCRs collected*

The concept of cost-benefit analysis (CBA) and computations of benefit-cost ratios (BCRs), in theory can help enterprises see the importance and effectiveness of implementing good OSH programs. The challenge is to develop a model that contains harmonized ways to classify and quantify costs and benefits.

From this study, we also can see that there are several factors that can affect the BCR such as duration of implementation and investment value of implementing OSH program.

d. *How findings can be used to help companies (and relevant stakeholders) in designing and implementing safety and health programs in the workplace*

This study shows that there is a systematic way to quantify benefits in order to justify an OSH program for a construction project. This BCR approach can also help estimate an appropriate investment amount on an OSH program based on the workforce size and OSH targets of a construction project. The findings can be used as a case study to raise awareness in the importance of implementing OSH, not only from the compliance perspective, but a worthwhile and value-adding undertaking.

The findings can also be used as benchmarks by construction enterprises in allocating budget for OSH and also gathering and monitoring safety data. Construction enterprises will get a realistic estimate on the percentage of cost associated to OSH and can put it in the budget. Data on accidents and incidents can also be used as standard key performance indicators in the construction industry.

e. *Conclusions*

These findings on economic justification on implementing OSH program is very useful and hopefully it can eliminate the stigma on implementing OSH that will certainly very useful for construction enterprises around the world, especially for Viet Nam. Findings from this study suggest that keeping a safe workplace has significant financial benefits. On the bigger scope, the result can also be used not only as a basis for an extensive study, but also as a basis for creating national or regional policy on implementing OSH at construction sector.

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