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HEALTH AND SAFETY PERFORMANCE IN INDIAN CONSTRUCTION SECTOR: A COMPARATIVE ANALYSIS BETWEEN THE PRIVATE AND PUBLIC-RUN LARGE SCALE ENTERPRISES

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Abstract— **The construction industry is considered as the second largest employer in India in 2023. Public and private run organizations differ in multiple dimensions including but not limited to their regulations, funding and ownership. There is a dearth of literatures over the "crude comparison of H&S management system between the public and private run construction enterprises in India". Thus, this research has endeavored to bridge that gap by carrying out a comprehensive comparative analysis on the H&S performance between these two types of organizations engaged in the construction sector of India and further come up with scope for improvements. The most ideal way of assessing the overall performance of H&S management system would be to analyze the combination of performance variables from both leading and lagging indicators. Since the implementation of a comprehensive health and safety management system in small scale or medium scale industries are very considered very rare, only large scale enterprises were considered for the study. The researcher made use of the Research Onion design, as developed by M Saunders, P Lewis & A Thornhill to guide the entire research process. This deductive research employed mono quantitative method as its research methodology and the required data were collected through a structured online survey from the select research sample of the research population, which consisted of occupational health & safety professionals those have had sufficient educational qualifications and experience working with both private and public enterprises engaged in the construction industry of India. The data collected were thoroughly analyzed descriptively & inferentially, which led to the ultimate conclusion that private run large scale enterprises engaged in the construction sector of India were faring significantly better in terms of H&S performance over the public run enterprises. The parent variable of leadership and worker participation in accordance with the ISO 45001:2018 was reported as the area which needs immediate improvement in the H&S management system for both private and public run large scale enterprises engaged in the construction sector India.**

Keywords—**Health & safety Performance, Indian construction sector, private run enterprises, public run enterprises, Comparative analysis, Comparison, Health & safety management system, Large scale enterprises.**

I. INTRODUCTION

A. Background of research -

Construction sector in India has grown very aggressively over the last couple of decades and the Government of India has even identified this particular sector as one of the pivotal driving factor for the economic growth of the country [1]. The construction industry is considered as the second largest employer in India in 2023 [2]. It was also the sixth largest FDI recipient sector for India in 2022 [2]. Construction industry contributes to 9% of India's GDP and employs nearly 51 million people across the nation [2]. It is also estimated that India will turn in to the third largest construction market globally by 2025 [2].

According to one public data published by the Government of India, there were a total of 148 fatality cases recorded from the construction industry from the year 2019 alone [3]. Now, albeit the government has developed a standard recording and notification system for construction accidents in India, its due implementation is far from effective and thereby accidents are highly underreported in the country. The accident statistics from the Indian construction sector is not properly regulated and published as public information as well [4]. The digital article published by NDTV on Aug 2017 [5], succinctly pointed out the crude amount of discrepancy in the accident statistics that is being compiled and recorded in the country.

Public and private run organizations differ in multiple dimensions including but not limited to their regulations, funding and ownership [24]. It is also widely accepted that there is significant difference in work motivation between the

employees of public and private run organizations [24]. It is observed that employees of public run organizations are less committed to their work than the employees of private run organizations [25].

It is also worthwhile mentioning that there were no literatures (published on or after 2015) available anywhere in Google Scholar/ ProQuest/ Academia/ ScienceOpen/ DOAJ/ Elsevier Journal Finder/ Research Gate over the "crude comparison of H&S management system between the public and private run construction enterprises in India". (The search for literature was done in Dec 2023). Thus, this research shall endeavor to bridge that gap by carrying out a comprehensive comparative analysis between these two types of organizations engaged in the construction sector of India and to come up with scope for improvements.

The most commonly used metrics to assess the health and safety performance of an enterprise are leading and lagging indicators [6, 7]. Lagging/ reactive indicators are often deemed as unreliable and inaccurate due the under-reporting practices on workplace incidents/ accidents/ illnesses [26, 27]. Health and safety performance evaluation based solely on the lagging indicators shall be deemed incomplete and deceptive, as they are not sensitive enough to identify the real time deterioration or improvement over the H&S performance [26]. Lagging indicators in any manifestation, do not provide any means to calculate the future health and safety performance as well [26]. Number of accidents at the workplace, accident frequency rate, worker's compensations paid out, number of days away from work due to occupational illness/ injury etc. are commonly used lagging indicators [14].

Now, leading indicators of health and safety performance are a metric that is often used to guide and evaluate measures undertaken to prevent and control the onset of an unwanted event [29]. Leading indicators are considered as a set of parameters which indicates the performance of pivotal work flows and processes and the effectiveness of the control measures and the protective layers implemented by the organization with the intend to avoid the occurrence of unwanted events [30]. Safety audits, toolbox meetings, H&S observation records, employee empowerment, risk assessments, H&S policy etc, are commonly used leading indicators [14]. However, the most ideal way of assessing the overall performance of H&S management system would be to analyze the combination of performance variables from both leading and lagging indicators, as this will promote the change for improvement in the long run and help attaining sustainable levels of workplace health & safety [31].

Now, the implementation of a comprehensive health and safety management system in small scale or medium scale industries are considered very rare [9]. There are a lot of reasons for this as well. Small scale and medium scale industries have a very limited financial and human resources at their disposal [9] and this makes it difficult for them to implement a comprehensive health and safety management in their workplace. During the onset of bad business scenarios where the business continuity is challenged, the leadership of small scale as well medium scale enterprises are reluctant to expend time and resources on issues that is not apparent in the real time [26]. OH&S is also not generally considered as a core value or priority in small scale as well as medium scale enterprises [26]. Also the managers of small scale as well as medium scale enterprises are less likely to be sensitized in the affairs pertaining to the occupational health and safety [9]. Due to all these findings, this research will focus only on large scale enterprises to understand the extend of health and safety performance in the workplace. According to OECD (Organization for Economic Co-operation and Development), large scale enterprises are defined as those that employ 250 or more people [10].

The data for this deductive research shall be collected from the occupational health & safety professionals who have had sufficient experience working with both private and public enterprises engaged in the construction industry of India, by means of a thoroughly formulated online survey. The questionnaire for the survey shall be meticulously formulated in such a way that it returns the most realistic reflection of the H&S management system of the organizations.

B. Background of research -

The fact that there is a continuous rise in the number of people employed in the construction sector of India makes this research all the more relevant as it is paramount to have a well implemented health and safety management system in all kinds of construction worksites, primarily to safeguard the people working there. However, the sheer lack of comprehensive and reliable data on the accidental statistics from the construction industry sector of India, makes it difficult for the scholars and the OHS professionals alike to assess the health and safety performance from the construction industry in India.

Albeit, there are several studies available over the digital platforms like Google Scholar and ProQuest, regarding the health and safety management system in the context of Indian construction sector, a comparative analysis of the same between the private and government owned large scale enterprises were not to be found anywhere, hence making this research first of its kind.

C. Aim of research -

The aim of this research is to compare the occupational health and safety performance between the private and government owned (>50% stakes owned by govt) large scale enterprises engaged in the construction sector of India, analyze and comprehend the kind of entity which is performing better in terms of H&S performance, identify the predominant areas for improving the H&S performance from both sides and further come up with recommendations to mitigate the shortcomings.

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D. **Research objectives -**

To conduct a comparative analysis on the occupational health and safety performance between the private and government-run (>50% stakes owned by govt) large scale enterprises engaged in the construction sector of India and then identify the kind of entity which is performing better in terms of H&S performance.

To identify the predominant areas of improvement in the occupational health & safety management system employed in the construction sector for both private and government-run (>50% stakes owned by govt) large scale enterprises in India, see whether there is a degree of dependence/ association between these predominant areas of improvement identified from both private & public run enterprises and further to come up with recommendations for mitigating the same.

E. **Research questions -**

Between the public (>50% stakes owned by govt) and private run large scale enterprises, which kind of entity is exercising a better H&S management system in the workplace and delivering better H&S performance in the construction sector of India?

What are the predominant areas of improvement in the occupational health and safety management system employed in the construction sector by the private and government-run (>50% stakes owned by govt) large scale enterprises in India and what is the degree of association between the two?

II. LITERATURE REVIEW

A review of 21 works of literature was conducted in such a way that the all the pertinent themes involved in the research are covered. The themes of the overall research are divided into 6 main categories, starting from the importance of H&S management in an enterprise, followed by relation between H&S management system and H&S performance, H&S performance in construction industry, H&S performance evaluation in construction industry, H&S performance and its evaluation in Indian construction industry and finally moving onto the performance difference between public and private run enterprises. In order to ensure fairness and parity, equal distribution of literatures (3-4 No.) are ensured across all the 6 main themes as well.

The literatures were sourced from internet platforms like Researchgate (42.86%), ScienceDirect (19.05%), MDPI (14.29%), Academia (9.52%), emerald insight (4.76%), IEOM society (4.76%) & IJNIET (4.76%). The distribution of literature across the timeline consists of 47.62% (3 years old), 33.33% (3-5 years old), 14.29% (5-7 years old) & 4.76% (more than 7 years old). It is worthwhile mentioning the one literature that is more than 7 years old is from the year 2016.

A. Importance of H&S management in an enterprise -

The study conducted by Saleem & Malik, 2022 [11] examines the pertinence of health and safety management and how it is tethered to the employee performance in an enterprise. They have stated that the improved or better occupational health & safety performance can always impart a competitive advantage to all kinds of enterprises in achieving the performance excellence, as root cause for the lion's share of all industrial disasters can be traced back to its inadequate safety management system. The framework of their research was the extrapolation of a health and safety management system to the individual safety performance of each employee in an organization through the development of safety consciousness and safety climate, while responsible leadership act as a moderator in this extrapolation. They concluded that the inculcation of safety consciousness and safety climate is essential for yielding a positive performance from a health and safety management system and that an effective and responsible leadership plays a rather prominent role in the health & safety performance improvement. However, this research has limited itself to one particular sector – pharmaceutical in Lahore, Pakistan, and thereby it cannot be generalized to other industrial sectors.

Kineber et al., 2023[39] in their comprehensive review of literature involving a total of 104 research articles, found that occupational H&S management system was first introduced in 1980s. They have also pointed out that implementation of H&S management system directly resulted in the reduction in the number of unwanted events in the workplaces as well as an increase in the quality of the health, safety & legal conformity. They also add that implementation of H&S management system always makes a positive impact on the overall safety performance in a workplace. All these findings are similar to the findings of Winge et al., 2019 [35]. The implementation of H&S management system yields several benefits to an organization including a safer work environment, decreased risk exposure for the employees, assimilation of H&S management in the project management, improved project management, availability of dedicated OH&S staffs etc. On the other hand, factors like low prioritization of H&S due to cultural variations in organizations, lack of H&S awareness for the top management & project managers, lack of sufficient investment in H&S, high employee turnover rate, unrealistic working schedules, subcontractor constraints, lack of active participation of project team in affairs pertaining to the H&S etc. presents a significant challenge for the implementation of H&S management system. Now, the H&S management system that was referred to in their literature review is OHSAS 18001. They found that OHSAS 18001 certified organizations have better & positive H&S culture compared to other companies who are not certified, and they emphasized that implementation of H&S management system plays a critical and strategical role in H&S in construction sites. Seven key elements were found to be influencing the implementation of H&S management system including commitment of the leadership over the implementation of H&S management system, formulating strategic objectives and policy, allocating resources, assigning clear roles & responsibilities to all levels of management, documentation and standardized document

control, comprehensive risk assessment process, proper planning, continuous proactive monitoring, auditing, reviewing & performance evaluation. This is however, different from the findings of Winge et al., 2019 [35].

Bavafa et al., 2018 [34] finds that a safety program or a safety management system is a proactive approach that needs to be implemented in a workplace to improve overall safety and wellbeing in the workplace as well as to develop a positive safety culture. The comprehensive literature review they did to identify the critical factors influencing the health and safety management system revealed 11 factors including allocation of safety incentives, development of safety training, deployment of competent safety supervisor and professionals, commitment of leadership and defining roles & responsibilities, performing safety inspections and job hazard analyses, developing a sub-contractors and personnel selection plan, formulating the relevant emergency response plans, ensuring employee involvement & safety evaluation, enforcing alcohol and substance abuse programs, conducting accident and near miss investigations and developing a comprehensive H&S plan. The study found 'Safety commitment and responsibilities' to be the most significant factor that influences the safety performance, as it was turned out as an absolute net effect factor.

B. Relation between H&S management system and H&S performance -

Marhavilas et al., 2022[43] in their review on international management system of occupational H&S, opines that it is through the implementation of a comprehensive H&S management system that an organization can keep on meeting their optimum H&S performance as the law and policies necessitates. They also find ISO 45001: 2015/2018, ILO OSH 2001 & OHSAS 18001:2007 as the most widely accepted H&S management system across the globe. The researchers also observe ISO 45001:2018 to be the most updated and comprehensive one amongst all, as it has assimilated the guidelines from OHSAS 18001 & ILO OSH 2001 along with other varieties of national standards. (It is worthwhile to mention that OHSAS 18001 was canceled by BSI, after the launch of ISO 45001.) They argue that the main goal of an H&S management system is to support and promote capable OSH practices in equilibrium with socio-economic necessities. They observe that the study conducted by British Safety Council (BSC) & International Labor Organization(ILO) revealed that an enterprise which adopts a H&S management system attains potential benefits including improved productivity from the workplace, reduced absenteeism among the employees, lowered compensation claims and insurance costs followed by the onset of accidents in the workplace, improved work psychology and morale amongst the employees and improved organizational reputation in the market. The researchers' states that a H&S management system constitutes an amalgamation of the planning and review, managerial regulations, consultative adjustments, and the essentials of a specific program, which collaborate together in a consolidated way to improve the overall H&S performance of an organization. The researchers confirm that a business from any category (commercial, industrial, etc.) and any size (small, medium, or large) can definitely implement a H&S management system, provided they are committed to the cause. They concluded their review by invariably saying that a H&S management system implemented by an organization engaged in sector/ industry can yield more efficient utilization of resources, enhanced financial performance, enhanced risk management, and increased productivity. However, these conclusions are based purely over a literature survey.

Morgado et al., 2019[44] opines that implementation of ISO 45001 H&S management system brings forth added value in terms of sustainability of organization, as it helps in improving the employee performance as well as the risk mitigation. The researchers opine that a H&S management system significantly increases an organization's ability to create safer and healthier workplaces as well as prevent work related injuries and/or health problems. The researchers see it beyond doubt, that the effective implementation of a H&S management always brings forth significant improvement in terms of overall H&S performance for an organization. All these findings are similar to that of Marhavilas et al., 2022[43]. Researchers come to realize that ISO 45001 is based on the Deming's or PDCA cycle (Plan - Do - Check - Act), usually referred to as the continuous improvement cycle, which will help the organization continuously improve its H&S performance. The researchers also state that implementation of ISO 45001 yields various benefits to the organization like increased productivity from the workplace, reduced costs inherent to work stoppages in the workplace, reduced costs of insurance and lost work days due to accidents in the workplace, improved product quality or services, all of which are aligned with the findings of Marhavilas et al., 2022[43]. Their deductive research done on select sample of Portuguese companies guided them to the conclusion that 98% of organizations actually realize the potential benefits, a comprehensive H&S management system bring in to their enterprise and some of the key benefits included reducing work-related accidents, increasing employee satisfaction/motivation, reducing costs of accidents and occupational diseases, improving the quality of products and services, reducing absenteeism and increasing productivity. However, since this research was conducted in the year of 2019, most of the organizations were making use of OHSAS 18001, as ISO 45001 came out just a few years prior to the time of research.

Yurizki & Ikatrinasari, 2022[45], states that organizations always tend to employ the H&S management systems like ISO 45001 & OHSAS 18001 in order to improve their occupational H&S performance. They argue that an organization's commitment to continuously review and improve its H&S performance can be demonstrated by complying with these H&S management standards. They go

on to add that ISO 45001 is a management system that helps organizations create and implement policies for the health and safety of their employees, and its purpose is to ensure that employees have a safe and healthy work environment, prevent accidents and diseases, and ultimately achieve the company's strategic objectives and business goals. Just like Morgado et al., 2019[44], the researchers find that ISO 45001 is based on PDCA/ Deming's cycle which drives towards continual improvement. They realize the implementation of ISO 45001 H&S management system starts with the commitment and leadership, followed by operational planning, risk assessment and control, leading finally to the process of monitoring, auditing, and evaluation of work entailing the management review. The researchers also invariably find that implementation of H&S management leads to an improved H&S performance, revalidating the findings of Marhavilas et al., 2022[43] & Morgado et al., 2019[44]. The data collected from a select sample in Indonesia, led the researchers to conclusions that implementation of ISO 45001 has a significant impact on organizations to reduce the workplace accidents as well as to increase their overall performance of the company. However, the data was solely collected from the steel industry of Indonesia.

C. Barriers to the implementation of H&S management in construction industry -

The research conducted by (Buniya et al., 2020) [15] aimed to identify the barriers to the implementation of H&S management system in the construction industry. A total of 12 barriers were identified by the researchers, which included lack of implementation of safety standards, insufficient resources for the effective implementation of the H&S management system, tight project schedule, inadequate commitment by the leadership to H&S, people regarding safety as something which needs lower priority, lack of training to the people involved over H&S affairs, lack of succinct safety rules and policy, assuming that safety is only the responsibility of safety professional deployed in the workplace , lack of generation and review of safety inspection reports, lack of awareness of the higher management over the considerations pertaining to H&S, lack of deployment of safety professional, and lack of competent workers in construction industry. The initially chosen 12 barriers were all concluded in to 4 main barriers by the end of the research, namely, unconducive work climate, poor safety awareness, poor governance and unsupportive industry norms. However, this research was done solely focused on the construction industry of Iraq, and hence cannot be generalized everywhere. Also, the data used for data analysis were collected only from 16 respondents, which is too low a number for representing a populace engaged in the construction industry. In addition to that, the discipline in which the respondents are working in the construction industry is not made clear in the research paper, as it could also influence the way in which they would respond. It would have been ideal, if the responses were taken only from the seasoned safety professionals engaged in different hierarchical levels.

D. H&S performance in the construction industry -

The review conducted by Mohammadi et al., 2018 [13] on the factors influencing safety performance in the construction industry diligently regarded construction industry as one of the most dangerous industries. They went on to add that the construction industry is constantly evolving and growing and put forth an alarming statistics showing, construction sector of US has nearly 6% of workers, but accounts for nearly 20% of workplace fatalities, which is the greatest figure for any industry. Construction sector is a pivotal factor in the progress of development for almost all countries as it directly contributes to the GDP growth of a nation. Mohammadi et al.,2018 even made it explicitly clear that the sustainability of construction industry is directly related to its health & safety performance and that it is an equally detrimental factor as cost, quality and time of a construction project. The comprehensive literature review conducted included 90 peer reviewed journals published from almost all continents of the globe, except Antarctica, initially yielded 113 variables worthy of being considered as factors influencing safety performance in the construction industry, which was again refined down to 13 main factors. After revalidation by a chosen sample, they concluded that, motivation amongst the employees to comply with the H&S requirements, H&S rules and regulations, competency of the H&S professionals deployed, investments on H&S and its associated costs, financial aspects and productivity of the organization, resource and equipment available in the workplace, work pressure amongst the employees, conditions in the workplace, safety culture and climate of the organization, attitude and behavior of the people, lesson learned from accidents, safety programs and the implementation of management systems as the 13 factors that influence safety performance in construction projects. However, the study has limited itself as the participants of the interviews only had experience in the Iranian construction industry. In addition to that, the study has not illustrated the interrelationship between these 13 factors and how exactly each of these factors could affect the health and safety performance.

Winge et al., 2019 [35] validated that safety management is considered as the amalgamation of management procedures and activities that targets to improve the overall safety performance in an organization. Safety management, occupational health and safety management system and safety programs are the common terms those are interchangeably used by different researchers, but it all bears the same meaning. They also stated that an organization with a certified H&S management system always tends to have significantly lower accident rates, although it is a matter of contention as to which factors of the management system contributes most to the overall H&S performance. They also agree with the statement of ISO 45001, that the effectiveness of a H&S

management system depends on various factors like top management leadership and commitment for the implementation of H&S management, communication protocols streamlined with the H&S requirements, consultation and participation of workers during the implementation of H&S management system, allocation of necessary resources, optimum risk management in the workplace, continual performance evaluation of the overall H&S management system and monitoring etc. The quantitative data analysis done by the researcher indicated that construction projects with integrated H&S management system tends to have better H&S performance. 8 factors from the initially chosen 16 factors were found to be absolutely necessary for high H&S performance, which included, roles and responsibilities, project management, OHS management and integration, safety climate, learning, site management, staff management and operative risk management.

Saeed, 2017 [38] in his research finds that the construction industry is contributing to the most number of workplace accidents than any other. They observe that the most number of fatalities recorded from the construction sector in UK from the period of 1997 – 2003 were due to falls from height. Other major reasons included electrocution, struck by moving equipment, trapped by collapse/overturning etc. All these observations are very much identical in the Indian context, as outlined by Saibabu et al., 2022 [36]. The data collection done through the questionnaire survey among professionals engaged in different disciplines in the construction sector and the entailing data analysis led to the conclusion that high rates of accidents are mostly due to various common factors such as lack of safety considerations in the design phase, poor construction planning, inadequate H&S training for the people involved, worker behavior, and lack of knowledge of site rules those are in place. The research also concluded that lack of sufficient H&S awareness for the workforce is the most significant influencing factor for H&S risks in developing countries. This conclusion is very much similar to that of Samanta & Gochhyat, 2021 [37], where they found the same issue as one of the prominent factor which impedes the H&S management of construction sector in India. However, the data collected for this research was compiled from only 39 participants and the sample was not made exclusive for the professionals from the discipline of H&S in construction. Also, the sample was spread in two countries UK and Iraq, which are in contrast with each other in terms of geopolitical standing and H&S standards. Iraq is a developing country whereas UK is a developed nation.

The study conducted by Khoza & Haupt, 2021 [33] states that construction industry offers maximum number of employment opportunities for the unskilled and semi-skilled workers. The purpose of their study was to develop an employer-driven H&S assessment model to be used in the construction industry. They observe that employer commitment to H&S performance in a construction project is pivotal in improving the overall workplace H&S amongst all the stakeholders of the project. The literature review they conducted revealed a total of 6 critical factors affecting the H&S performance in organization and project level. It included employer's attitude towards H&S, employer's communication over H&S affairs, selection of contractors, H&S contractual requirements, employer involvement before and after the construction and employer monitoring over H&S performance. However, the deductive research, further concluded that only H&S contractual requirements has influence over the H&S performance in the workplace and all the other 5 chosen critical factors were only exerting an indirect influence, as all these factors are mutually dependent. However, this study was done strictly in the purview of employer involvement, which is just one of many aspects which dictated the performance of a comprehensive H&S management system in a workplace and hence, this framework cannot be used for a comprehensive evaluation.

E. H&S performance evaluation in the construction industry -

A review of health and safety management performance measurement in the construction industry conducted by (Boakye, 2022) [12] asserted that, alike any other management processes, the H&S management systems deteriorate over the time, as the way of job execution, materials, people and equipment is consistently evolving. It is therefore, imperative to have a performance assessment on health & safety management system to ascertain if the existing control or mitigatory measures are still adequate and effective, and if not, what more and where more are required to sustain the optimum performance of the enterprise. He observes that the health and safety performance in an enterprise was conventionally measured on the basis of outcomes or lagging indicators whereas the contemporary measurement metrics are based on pro-active/ predictive or leading indicators and sometimes with a mix of both lagging & leading indicators as well. Boakye, also added that lagging indicators like number of accidents and illnesses, number of days away from work and near misses etc. are not suitable enough for the evaluation of health and safety management performance, as these data will only come to the surface after the onset of an event, consequently it gives little to zero indication on the actual performance of the H&S management system before the event, making timely implementation of corrective/ mitigatory measures for avoiding the onset of the same event impossible.

On the other hand, leading indicators like number of audits, risk assessments, trainings, inspections, safety checks etc. conducted in the workplace, gives off a rather reliable early indication on the deteriorations or challenges in the H&S management system. Attending to the challenges identified, can help the enterprise avoid the onset of an unwanted event as well. Boakye concluded his review by saying that the performance of H&S management system can be assessed using several techniques to ensure the continual improvement of the system. However, the Boakye in his review, didn't

venture out to sort out the best set of variables for assessing the performance of H&S management system in an enterprise.

Elsebaei et al., 2020[40] finds that H&S performance of an organization can be normally measured on two concepts, lagging indicators and leading indicators. Lagging indicators are based on failures in the past or unwanted events in the workplace, whereas the leading indicators provide a future forecast of the H&S performance based on the activities and practices implemented in the workplace, not incidents/ failures. The examples outlined by the researchers for leading & lagging indicators were similar to the ones listed by Boakye, 2022 [12]. The researchers argue that lagging indicators are commonly used to measure the H&S performance, but they also realize a pitfall with the method, which is that these measurements are used only to highlight the absence of safety, but not the presence of safety, as they consider only the past incidents which have already occurred. The researchers find leading indicators to be proactive in nature and very practical to help improve the H&S performance in a workplace.

Naji et al., 2020[31] in their research on the implementation of leading & lagging indicators to improve safety performance, describes safety performance as the "quality of work relating to safety". They find that evaluation of organizational H&S performance helps companies evaluate their management efficacy & the primary purpose of measuring performance in H&S is to provide information over the progress and current status of an organization's policies, processes and their measures to control H&S risks. Just like Elsebaei et al., 2020[40] & Boakye, 2022[12], they find that performance of H&S management is normally evaluated using two metrics, leading and lagging indicators. The description, examples for the lagging & leading indicators outlined by Naji et al., 2020[31] were similar to that of Elsebaei et al., 2020[40] & Boakye, 2022[12]. However, the researchers concluded that both these metrics/ concepts are equally essential to measure the performance of H&S management, and the best way to do that is by combining leading and lagging indicators which will help organization attain a long term, sustainable level of H&S performance. This conclusion is somewhat similar to the findings of Boakye, 2022[12] where they observe that the contemporary measurement metrics sometimes employ a mix of both lagging & leading indicators.

F. H&S performance & its evaluation in the Indian construction industry -

Singh & Misra, 2021[16] proposes a framework to evaluate the safety performance of workers in the Indian construction sector. It is well stated that the optimum performance of health and safety in an enterprise can help increase their profitability, productivity and growth in a faster rate, but it is equally paramount to periodically review or measure their H&S performance to ensure a continual improvement. The primary objective of an assessment of H&S performance is to ascertain the enterprise's preparedness to avoid and control the onset of unwanted workplace events. The researcher's aim to identify the key performance indicators of H&S performance yielded 11 categories of indicators. Safety plan, organizational safety, specialized safety rules, monitoring safety, safety equipment, prompt response to emergency, sub-contractor selection & evaluation, safety panels, promotional activities related to safety, execution of the project & psychological factors were the 11 categories. The prioritization and ranking of these indicators was done by the researchers showed a very high level of inconsistency between different management levels of enterprise which revealed the conflicting priorities each level of management has, with regards to the health & safety performance. The study found out that the most detrimental factor in achieving an optimum H&S performance is the visible commitment and involvement by the top management of the organization to the cause. This is aligned with the findings of Kineber et al., 2023[39]. Requirement of training and documented safety procedures, safety manual etc. were also found to have ranked pivotal. The sample chosen for this study was a single small scale construction enterprise in India. Now, Tremblay & Badri, 2018[26] and Masi et al., 2014[9] have found that H&S management between SME and large scale enterprises are quite different as implementation of a comprehensive H&S management system in small scale or medium scale industries are very considered very rare. and thereby, the results of this study cannot be generalized all across India, since majority of the construction firms in India are large scale in nature.

Saibabu et al., 2022 [36] observes that, as per the latest government data available, nearly 73% of the total construction workforce employed all across India are unskilled and uneducated. The fact that these people are uneducated makes it difficult or next to impossible for them to comprehend the principles of H& management or how that works. The literature review conducted helped them to realize that most number of workplace fatalities in the construction industry of India occur due to fall from height. They also found collapse/ overturn, struck by moving vehicle, electrocution and struck by falling object to be prominent causes for workplace fatalities as well. Their work also revealed that majority of the workplace accidents occurring in India are somehow related to the lack of health & safety knowledge by the people engaged.

The critique done by Samanta & Gochhyat, 2021 [37] on occupational H&S in the Indian construction sector finds that H&S situation in the construction workplace in India is below the general global standard, which leads to the relatively higher number of workplace accidents. The comprehensive literature review conducted by the researchers aimed at identifying the important challenges for the H&S management in the Indian construction sector revealed 7 issues. Workplace ergonomics, use of PPE and safety measures, communication system at construction sites, training, psychological factors, safety orientation and culture, and finally, safety & health legislation. The survey done in a sample of 100 participants,

revealed that lack of proper training, awareness as found by Saibabu et al., 2022 [36], along with lack of usage of PPE, psychological factors and wrong workplace ergonomics are the most pertinent issues as more than 75% respondents have had faced these issues in their workplace. However, the selection criteria for sample population is not made clear in the paper, which gives the readers ambiguity regarding the credibility of the data collected.

G. Performance difference between public and private run enterprises -

Blaskovics et al., 2023 [17] tried to understand the differences between private sector and public sector project management practices in Hungary from a competency point of view. They have tried to define the private and public sector enterprises on the basis ownership, where public enterprises are those owned by the members of the political communities or otherwise 'publicly funded' and private enterprises are those owned by private shareholders, commercial legal entities or individuals. They argue that public and private enterprises differ in their permeability, complexity, instability, absence of competitive pressures etc. The researchers developed four hypotheses to guide their investigations which mainly outlined the interrelationship between failure rate and success rate between the private and public enterprises. The hypothesis also considered the importance of knowledge areas and skills between the private and public enterprises, as it was observed by the researchers that project management competencies can be grouped in two categories of knowledge and skill. Their sample population included 13 public and 36 private organizations and contained both SMEs and large scale enterprises. Most number of responses were obtained from the industry of Information & Technology (17 No.) and only 4 responses were recorded from the construction & real estate sector. The researchers concluded that there were no significant differences in the project management performance between the private and public enterprises and thus, they rejected the three out of four hypotheses they had initially formulated for the research. However, the researchers partially accepted their fourth and last hypothesis and found there was difference in the perceived pertinence of skills regarding business acumen and customer orientation between the private and public enterprises. However, this study cannot be necessarily generalized even all across the nation of Hungary due to its rather small sample size of 49 respondents, let alone anywhere else in the world. Also, the degree of knowledge and skill requirement varies from industry to industry. The research done by Blaskovics et al. didn't just focus on one particular industry, rather it was a mish-mash of all the industries that was part of Hungarian Project Management Association. The results of this research could have been more pertinent & coherent, if it was done on one particular industrial sector.

Hatmoko & Khasani, 2016 [41] in their research, aimed to compare performance of government and private clients in construction projects as perceived by contractors, stated that success in the construction projects is primarily driven by the skills and knowledge of the client or the Employer of the project. They argue that by nature, government and private organizations differ in various characteristics, as public organizations tend to have more complex and longer bureaucracy than the private enterprises. They also observe that the construction projects undertaken by a public enterprise generally makes use of the traditional route of procurement, i.e. design-bid-build, whereas the private enterprises are more flexible, where they are known to make use of design-bid-build (D/B/B), design-build (D/B), engineering-procurement-construction (EPC) strategies. The researchers also find that private enterprises can use their own funding, whenever and however they want to build the project or even obtain loan from financial institutions which offers more room for flexibility in their operation, as opposed to their public counterparts where they are always bound to certain regulations in terms of project procurement. That data collected from 117 respondents (57 public, 60 private) & the entailing data analysis concluded that private enterprises generally performs better than public enterprises in terms of project execution in construction industry. However, out of the six performance indicators, timely payment, suitability of owner value estimate, and ease of payment approval, are least performing indicators of the government client, whereas these three indicators are in top three for the private clients, which is of a stark contrast. The performance over the financial indicators are generally perceived to be inferior for the public enterprises when it comes to the project execution in construction industries. However, this research was not at all done in the context of occupational H&S management system, rather, the execution of a project as a whole is considered here.

Gupta & Kumar, 2020 [42], have done a research on the comparison between the public and private enterprises in an Indian context. They find that the profitability of public owned enterprises in India is generally lower than that of private enterprises engaged in the same industry. They further argue that due to reasons like principal–agent problem, property rights issues including ownership concentration and ownership transferability, fuzziness of the owners' identity, politicization of public owned enterprises leading to corruption etc. public enterprises generally tends to have low operational performance resulting in poor financial well-being in India. However, the researchers have emphasized to note that almost all studies with a comparative analysis between private and public enterprises done till date have compared only the technical or financial performance parameters of the two sectors, and so, it is myopic to come to an invariable conclusion since there are many other parameters that needs to be analyzed and compared in an enterprise. They also note that public enterprises more often focus on social objectives such as maximizing employment and developing backward regions and that, the pulls and pushes of various interest groups in society tend to influence the decisions of a public enterprise.

The case is quite opposite in case of private enterprises though, where the major share stakeholders of the enterprise will be making all the decisions with a purely profit-generating motive, irrespective of the trend among the general population. The three hypothetical propositions of the research: wages of workers in India are higher in public enterprises than that of private ones, public enterprises fulfill universal service obligations as opposed to private enterprises, and the last one, public enterprises have a better social mix of employees than in private ones were proven correct and valid by the researchers. They also concluded that at present, comparisons of private and public enterprises in India are without merit, as the research community has still not covered this comparative analysis holistically.

The research work done by (Rojas et al., 2020) [08], compares the maturity measurement results of health and safety management in 30 private organizations and 50 public organizations based out of Bogota, Columbia. Researchers developed a health and safety management maturity measurement instrument through 10 variables, namely, OSH policy, strategic analysis, legal constraints, communication and participation, strategic positioning, health & safety integration in the organization, evaluation of H&S management, strategic planning, H&S management capacity in the organization and planning on learning. The results of the research led to the conclusion that variables like OSH policy, participation and communication, strategic analysis and H&S evaluations were performing better in the public organizations and conversely, elements like legal aspects, H&S management integration with other management systems of organization, capacity planning, strategic planning and organizational learning were found to be performing better within the private organizations. A total of 6 variables out of 10, were found to be exhibiting significant differences between the public and private enterprises. Rojas et al., also realized that three variables namely, legal aspects, H&S evaluation and strategic position did not show significant difference between private and public enterprises. This research has limited itself just to the comparison of the H&S management maturity measurement instrument, rather than trying to compare the maturity level itself of the H&S management itself between the private and public enterprises. In addition to that, the research hasn't considered the kind of industry these 80 organizations are working in, and its impact on the maturity level of the H&S management. It is a known fact that the soundness of the H&S management system differs from industry to industry.

H. Research gaps -

There is literally a dearth of literature outlining the difference in H&S performance between a private and public run enterprise in India, let alone from the construction Industry of the country. It is also worthwhile mentioning that there were no literatures (published on or after 2015) available anywhere in Google Scholar/ ProQuest/ Academia/ ScienceOpen/ DOAJ/ Elsevier Journal Finder/ Research Gate/ ScienceDirect over the "crude comparison of H&S management system between the public and private run organizations in India". (The search for literature was done in Jan 2024).

A large quantity of the research works done on the domain of health & safety in construction has collected data from all kinds of discipline involved in the construction, rather than choosing a sample exclusively consists of H&S professionals, who can provide the most credible data. E.g. Saleem & Malik, 2022[11], Yurizki & Ikatrinasari, 2022[45], Saeed, 2017[38], Khoza & Haupt, 2021[33], Buniya et al., 2020[15], Elsebaei et al., 2020[40], Singh & Misra, 2021[16], Hatmoko & Khasani, 2016[41]. Involvement of people belonging to different domains of construction, where they might lack clear and succinct understanding on H&S principles and program, can lead to corruption in the data collected.

A sizeable quantity of the research has not considered the scale of the organizations from which the research data is collected, as it is clearly shown by Tremblay & Badri, 2018 [26] and Masi et al., 2014 [9], that H&S management between SME and large scale enterprises are quite different as implementation of a comprehensive H&S management system in small scale or medium scale industries are considered very rare due to various reasons. This could have led to a corruption in the research where data from both SMEs and large scale enterprises are collected and analyzed together as one single set. E.g. Saleem & Malik, 2022 [11], Morgado et al., 2019[44], Saeed, 2017 [38], Elsebaei et al., 2020[40], Singh & Misra, 2021 [16], Blaskovics et al., 2023 [17], Rojas et al., 2020 [08].

Almost all studies with a comparative analysis between private and public enterprises done till date have compared only the technical or financial performance parameters of the two sectors, and so, it is myopic to come to an invariable conclusion since there are many other parameters that needs to be analyzed and compared in an enterprise. My research, hence, will be contributing significantly to the research community in India, and adding value to this ongoing process of reaching a holistic comparative analysis between the private and public enterprises, by choosing a new & different parameter, that is H&S management system/H&S performance.

III. RESEARCH METHODOLOGY

The researcher shall be making use of The Research Onion design to guide the entire research process. The research onion design was developed by M Saunders, P Lewis & A Thornhill in 2015. The research onion design starts with the research philosophy and the whole research progress through different layers of this design in a sequential manner till the ultimate stage of data collection and data analysis. The progression of research is as depicted as follows (Figure 1):

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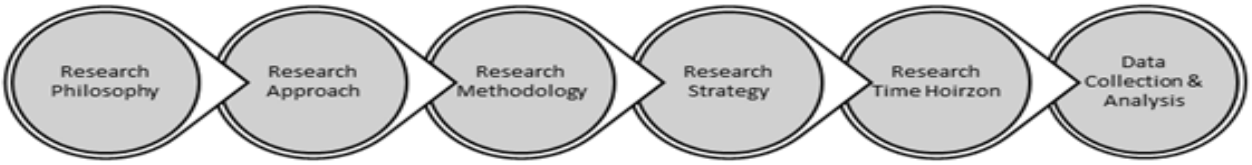

Fig. 1. Research methodology progression

A. Research philosophy -

The key research question of comparing the extend of occupational H&S performance in the construction sector between the private and government-run large scale enterprises in India shall be answered objectively on the basis of quantifiable data collected from a select research sample. The areas of improvement for both private and public run enterprises with regards to their H&S performance shall also be collected objectively by providing a defined and confined array of options/elements that forms part of the same survey for the sample to choose from. This will be helpful in avoiding the huge accumulation of random ideas, which could lead the researcher to make speculations. Since the researcher truly believes that the findings of a research shall leave nothing for speculation, but be of something that emerges from a quantitative analysis, researcher intends not to leave anything for interpretivism. Thus, the research philosophy adopted here is positivism as the researcher is an objective analyst and the role of researcher is the data collection and its interpretation in an objective manner. Positivism is based on the idea that natural scientists observe and study the reality within society to make generalizations [19]. Positivism is based on the ontology that there is only one reality and it is objective in nature [19]. Also, the research done here will be independent in nature with no considerations given to the human interests of the sample population.

B. Research approach -

Research approach employed here is deduction as this research starts with a well-established theory and then ventures out to test the implication or relevance of it by making observations & doing data collection and analysis. The researcher here intends to make his analysis using the pre-existing constraints established by the existing theory or research findings, which essentially makes it a deductive research [20].

C. Research methodology -

Since the comparative analysis of H&S performance between the private and public run large scale enterprises engaged in the construction sector of India shall be objectively analyzed backed up by numbers, the research will indeed be quantitative in nature. As the researcher is, by belief, a positivist, this research shall not divulge into a mixed method at any point. It is worthwhile mentioning that the research carried out here is not funded and collaborative in any manner. Although, this research can employ a multi method, it is unlikely for it to amount additional value into the overall research journey. For instance, if a multi method were to be adopted, say a combination of survey and interview (narrative inquiry), the questions that will be asked in an interview or a survey will essentially be same and both the feedback will eventually lead to the same binary representation. Doing so, will only lead to an additional exhaustion of researcher's resources, siphoning little to no additional value into the data pool. Archival research is also unlikely to add value to this research, as there is a dearth of literature over the comparative analysis of H&S performance between the private and public run large scale enterprise engaged in the construction sector of India. The same is actually identified as a gap in the literature as well. In view of the research objectives, archival research based on a company documented data can also be deemed not suitable. Conducting experiments cannot add value to the process at all as the research here is deductive in nature. This research can never be a case study either. All of these reasons led the researcher to an invariable realization that mono method is the best suitable approach for the research. Moreover, the contemporary relevance of mono method was further revalidated by Aguirre & Robles, 2020[54] by analyzing the distribution of 127 research articles selected from the period of 2018 to 2019 published in the International Journal of Project Management. They found 96 No. (76%) of the research works to have used mono method, 19 No. (15%) employed multi method and 12 No. (9%) made use of mixed method.

Simply put, the research shall employ the mono-quantitative methodology as it intends to exercise the collection of a set of data through a single strategy and analyze the same on the basis of numerical values [21].

D. Research strategy -

The research shall be making use of survey strategy, as survey strategy features the use of self-generated measures on the selected samples and it is a flexible method that can be employed to gather data over a myriad of basic and applied research questions [46]. Hence, the researcher intends to collect all his data through structured surveys from a representative sample from a population. The survey questions shall be structured, as these questions will be formulated on the basis of internationally recognized ISO standard, ISO 45001:2018. ISO

45001 is an international standard that specifies requirements for an occupational health and safety (OH&S) management system [55]. It provides a framework for organizations to improve its OH&S performance [55]. The standard establishes criteria for an OH&S policy, objectives, planning, implementation, operation, auditing and review. Key elements include leadership commitment, worker participation, hazard identification and risk assessment, legal and regulatory compliance, emergency planning, incident investigation and continual improvement [55]. All the survey questions shall be based on these key elements of the ISO 45001. The survey shall be done over the internet platforms like google forms, and respondents will be answering remotely via internet. This is so that the respondents can participate in the survey according to their own convenience as it might take up to 15 minutes to complete the survey. The flexibility, robustness and the data security offered by the internet platforms like Google forms, Microsoft forms etc. are unparalleled. These platforms are accessible 24x7 and they save the survey responses of the respondents into the survey originator's data pool in the real time as well.

E. Research time horizon -

Since the researcher will only be studying the sample at one certain period of timeline, the time horizon chosen here will be of cross-sectional in nature [23]. The key research objective of conducting a comparative analysis on the occupational H&S performance between the private and government-run large scale enterprises in the construction industry of India can be successfully achieved even if the sample is studied at one particular of point in the timeline, as the data, the researcher intends to collect, is purely based on the working experience and acquired knowledge the subject possess in that selected time interval.

Hatmoko & Khasani, 2016 [41] found significant differences in the overall project execution between the public and private run client organizations engaged in the construction projects and Rojas et al., 2020) [08] found differences in the performance over the elements of H&S maturity between the public and private run organizations. Based on these findings, the researcher here expects to see a remarkable difference, if not similar, over the health and safety performance between the private and public run large scale organizations engaged in the construction sector of India, by doing a cross-sectional study.

F. Data collection & analysis -

Research population chosen for this research would be occupational health & safety professionals who have had experience working with both private and public enterprises engaged in the construction industry of India.

The educational qualifications serve as primary indicators of the potential of a person, where his/her actual level of competencies can only be confirmed over the time through active monitoring [48]. Since the researcher has no way to actively monitor all of the sample population to assess their actual competencies, researcher sets an exclusion criterion for their formal education as either a bachelor's degree or a technical diploma. It is worthwhile mentioning that acquisition of a bachelor's degree generally accounts for the development of critical thinking and problem solving skills in the people [49]. Now, the Technical Education & Vocational Training System (TEVTS) in India produces the labor force through a 3 trier system in the country [50]. Graduate and postgraduate level specialists trained as engineers and technologists; diploma-level graduates who are trained in polytechnics as technicians and supervisors; and certificate-level craft people [50]. It is also recognized by the TEVTS of India that Diploma level education produces skillful personnel who can work in an industrial setting [50].

Since, the skill gaps incurred by the person after the formal education can be further reduced by post-educational work experiences [48], the researcher puts forth another exclusion criterion regarding the level of working experience for its sample population. BBC, UK, in one of their online article stated that staying in a job for a minimum period of 12 months gives enough time for an employee to pick up skills and competencies pertaining to their job role [51]. They also went on to quote Alison Sullivan, the senior manager of corporate communications at Glassdoor (one of the world's leading jobs site) by saying that, an employee generally feels they have hit stride in their job role after a year [51].

Hence, the sample group chosen for this study would be the occupational health & safety professionals those have achieved either a bachelor's degree or a technical diploma, and have had a minimum of one year of experience working with both private and public large scale enterprise engaged in construction industry of India. The sample need not be directly employed under the enterprise in any case though, as working under the client ship of an enterprise, be it private or public, is suitable enough. In order to increase the credibility of the data collected, the researcher shall endeavor to understand the hierarchical distribution of the sample in the profession of occupational H&S. The researcher shall make his best efforts to obtain an even distribution across 5 hierarchical levels, namely, officer/supervisor, engineer, deputy manager/ coordinator, manager/ general manager and above general manager positions. However, the researcher may fail to meet this objective. This is because of the level of filtration already exists in the sample population that is considered eligible for this study. The same is illustrated in Figure 2.

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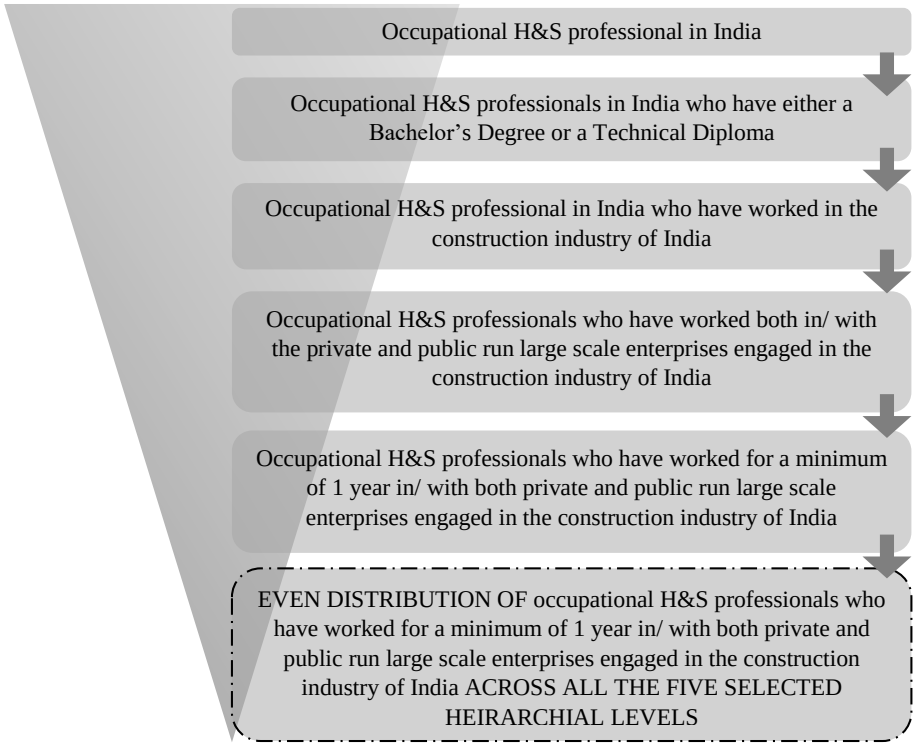

Fig. 2. Research sample selection

G. Sampling technique -

A systematic probability sampling shall be done initially to ensure the selection of a representative sample that is competent and eligible enough to provide reliable primary data with reasonable credibility for this research. The occupational H&S professionals who have worked for a minimum of 1 year in/ with both private and public run large scale enterprises engaged in the construction industry of India would be the sample who shall be considered "eligible" for the data collection process.

H. Sample size -

The researcher intends to get a minimum of 100 surveys completed/ respondents from the sample population, so that the results of the research can be used to generalize all across India. The online article published by World oil (world's leading technical publication for upstream professionals) in 2022 stated that most statisticians agree that a minimum of 100 sample size shall return a meaningful result for survey researches [52]. This was concurred by UK Space Agency in their document titled Monitoring & Evaluation (M&E) Tools and Techniques, V 3.0 as well [53].

It is worthwhile mentioning that due to the high rate of filtration constraints (illustrated in figure 2) applied on the sample population, it might get difficult for the researcher to collect the data from a sample size significantly larger than 100. Albeit, the researcher, in his endeavor to make the data pool as reliable and credible as he could, shall put forth his best efforts to collect as much as responses possible.

I. Data analysis -

The researcher shall employ a mix of descriptive and inferential data analysis techniques to draw conclusions from the data collected from the sample populace through the survey. As the researcher here is a firm believer of positivism and the methodology chosen is mono-quantitative, the primary objective of the research shall be achieved by running appropriate non-parametric tests on the data with the help of SPSS software. The tests shall be of non-parametric in nature as the collected data would be in either nominal or ordinal scale. Considering the dichotomous nature of the variables laid out in the survey questionnaire, Binomial testing would be best suited for hypothesis testing with the null hypothesis representing the same and equal level of H&S performance between the private and public run enterprises.

The secondary objective of finding the predominant areas for improvement and comprehending the degree of dependence/ association between them would be achieved by a conducting a comprehensive descriptive analysis followed by the chi-square test of independence. Chi square test of independence is rightly suitable for achieving the secondary research objective, as it is a correlation analysis method which can be performed on non-parametric data, with the null hypothesis representing the independence or lack of association between the two variables.

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Furthermore, the reliability analysis shall be performed over the survey questionnaire in order to assess the ability of the instrument to measure consistently and reliably for extrapolation. The Cronbach alpha value of 0.7 or above shall be considered acceptable for the statistical analysis. In addition to that, validity of the survey questionnaire shall be assessed by running KMO and Bartlett's test and KMO below 0.5 are normally considered not acceptable [60].

The progress of this entire research with reference to the Saunder's research onion [18] is depicted in Figure 3.

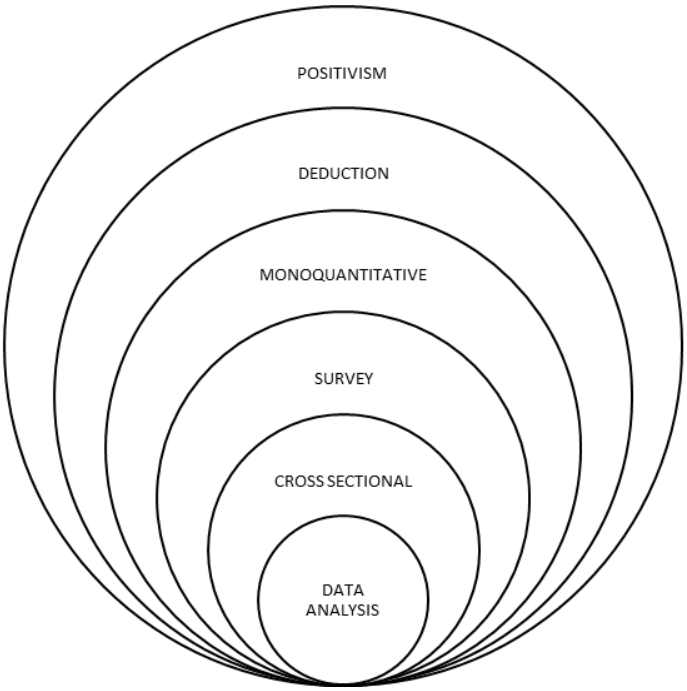

Fig. 3. Research progression

IV. DATA COLLECTION & ANALYSIS

The most ideal way of assessing the overall performance of H&S management system would be to analyze the combination of performance variables from both leading and lagging indicators, as this will promote the change for improvement in the long run and help attaining sustainable levels of workplace health & safety [31]. The literature review conducted herein explicitly revealed that the H&S performance of an organization is directly related to the level of compliance with the H&S management system that is in place. As the primary research objective here is to conduct a comparative analysis on the occupational H&S performance in the construction sector between the private and government-run (>50% stakes owned by govt) large scale enterprises in India, the researcher shall revert to ISO 45001: 2018 management standard for comprehending the building blocks or key elements of an ideal & most standardized H&S management system [43].

According to ISO 45001: 2018 [55], the building blocks or key elements of an ideal H&S management system is as follows (Figure 4).

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Leadership & Worker participation	Leadership & commitment
	OH&S Policy
	Organizational roles, responsibilities and authorities
	Consultation & participation of workers
Planning	Hazard identification & assessment of risks/oppurtunities
	Determination of legal requirements
	Planning action
	OH&S objectives
	Planning to achieve OH&S objectives
Support	Resources
	Competence
	Awareness
	Communication (Internal & External)
	Documented information (Creation, updation & control)
Operation	Elimination of hazards & reducing risks
	Management of change
	Procurement
	Emergency preparedness & repsonse
Performance evaluation	Monitoring and performance evaluation
	Evaluation of compliance
	Internal audit
	Management review
Improvement	Incident, non conformity and corrective action
	Continual improvement

Fig. 4. Building blocks of H&S management system

Thus, the data gathered from ISO 45001:2018 gives this research its string of independent variables. As the research shall be employing the survey strategy, a structured survey questionnaire shall be developed on the basis of these independent variables. The structured questionnaire developed is illustrated in Figure 5.

The survey is broken in to 3 sections, where first section collects basic information of respondents including their name, state in India that they hail from, age, gender, current hierarchical position in their H&S profession, whether they are bachelor's degree graduate or technical diploma holder, their total working experience as a H&S professional in the construction industry (large scale enterprises only) of India and finally, about their working experience either as an employee or under the client-ship of private and public run large scale enterprises engaged in the construction sector of India. The data from this first section of the survey shall be detrimental in filtering the eligible sample population from research populace.

In the second section, the respondents of the survey were asked to choose the type of enterprise [private or public run (>50% stakes owned by govt)] they have found to be doing better/ superior in every independent variable, based on their working experience in the large scale enterprises (more than 250 employees) engaged in the construction sector of India. The data collected from this section of the survey shall help achieve the primary research objective.

Finally, the third section of the survey, shall collect the individual feedback from each respondents regarding the top 3 elements of H&S management system where the large scale private and public run enterprises engaged in the construction sector of India needs to improve significantly and in a priority basis? All the variables established here in the research shall be listed for the survey respondents to choose from. Thus, the data collected from this last section of the survey shall help achieve the secondary research objective.

The survey strategy was executed using the Google Forms and the same was available for the research population to mark their responses 24x7. A total of 146 respondents marked their response in the survey.

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Leadership & commitment	Leadership involvement & commitment over the affairs pertaining to EHS/ OHS in the FIELD/ actual workplace.
OH&S Policy	OHS/ EHS Policy is formulated, frequently communicated to the employees and more often endorsed by their leaders.
Organizational roles, responsibilities and authorities	Organizational roles and responsibilities of each employees are well defined and same is clearly communicated with all.
Consultation & participation of workers	Workers Participation & Consultation: The worker representatives are involved in the health and safety committees and their concerns and responses are recorded and valued more.
Hazard identification & assessment of risks/oppurtunities	Hazard identification and risk management/ assessment process more effectively developed, followed, practiced, reviewed, continuously improved and that all activities are commenced in the field after conducting a risk assessment.
Determination of legal requirements	All the applicable legal requirements pertaining to EHS/OHS are identified and documented and the periodic review of the
Planning action	same against the level of compliance of the organization is carried out. Legal register is regularly updated, as needed too.
OH&S objectives	EHS Objectives and KPI targets well formulated, continuously tracked and periodically reviewed for its achievability.
Planning to achieve OH&S objectives	
Resources	Resources: The organization has identified, allocated sufficient budgets and delivered all the required resources needed for the establishment, implementation, maintenance and continual improvement of the H&S management system.
Competence	Training & competence : Training on the affairs pertaining to the EHS/ OHS to be happening in a systemic way, in pre-planned time intervals to all the employees from all the departments and the entailing competency assessment protocols.
Awareness	EHS awareness programs are periodically carried out involving all employees (campaigns, competitions, exhibitions, newsletters, flyers etc.)
Communication (Internal & External)	A comprehensive, controlled system is developed and implemented to share relavant information pertaining to EHS with both internal and external stakeholders of the organization.
Documented information (Creation, updation & control)	Comprehensive and standardized EHS/ OHS document management system, with a clear minimum requirement for the document types and a set time for its periodic review and that all of these documents are made accessible to all the employees in the organization.
Elimination of hazards & reducing risks	Implementation of their own EHS/ OHS procedures, manuals, control measures from risk assessements are more visible and apparent in the field.
	OH&S inspection regime for all system, tools and equipment are well developed, documented and exercised as a cross functional drive with participation of authorized people from concerned departments and that the results of all these inspections are recorded and made accessible to all the concerned employees.
Management of change	A comprehensive plan is developed to control and manage all kinds of changes that can impact the EHS performance of the organization.
Procurement	Contractor selection and outsourcing process well-developed, documented, implemented and continuously exercised, updated and reviewed.
Emergency preparedness & repsonse	Emergency preparedness and response well developed, documented, implemented, exercised and continuously improved for all kinds of probable emergency scenarios.
Monitoring and performance evaluation	Individual performance of all the employees over the level of EHS compliance is periodically evaluated, appraised and
Evaluation of compliance	rewarded/ reprimanded in a systematic manner and recorded.
Internal audit	Health and Safety Audits (First party & Third Party) happening in a systematic way in fixed intervals in a transparent and
Management review	effective manner along with a comprehensive system facilitating the management review to follow up all the corrective and preventive actions aimed at continuous improvement.
Incident, non conformity and corrective action	Continual improvement process is well developed, exercised and that all the corrective as well as preventive actions identified from all EHS violations, incident investigations, root cause analysis, audits are recorded along with a well
Continual improvement	defined action plan with clear identity of people accountable & target dates. This is also ensued by follow- up evalutions to ensure the effectiveness of its implementation.

Fig. 5. Structured questionnaire

A. Data analysis: Demographics -

A total of 146 respondents marked their responses in the survey and out of which, 44 respondents didn't meet the exclusion criteria set out for the sample population. This indicates that only 70% of the total survey respondents were actually considered as the sample population for the research. Furthermore, the data also indicated that, out of 44 omitted respondents, only 2 respondents didn't meet the educational qualification criteria and the remaining 42 respondents didn't meet the experience criteria set out for the sample population.

The filtered 102 respondents that becomes the part of sample population were all spread out across different states in India. However, exactly 50% of the sample population were from the state of Kerala. The fact that author of this study is hailing from Kerala has led to this natural bias in the sample population. Nonetheless, responses were collected from people in all 4 directions of the country (North, South, East & West). The classifications of states across zones (North, South, East & West) is done with the reference of mapsofindia website [56]. 72% of total respondents were hailing from south zone of India, 11% were hailing from east zone, 9% from west zone and 8% from the east zone.

The sample population consisted of H&S professionals different age groups. About 54% of the total sample population were from the age group of 30-39 whereas the 32% were from the 20-29 age group. Now only 2% of the sample population were of age 50 or above and 12% were of 40-49 age group. This indicates the predominant presence of young to middle aged subjects in the sample population

The entire sample population which consists of 102 subjects were all male. It is also worthwhile mentioning that the original total 146 respondents didn't even include one female either. This indicates that the occupation of H&S professionals engaged in the construction sector of India is predominantly dominated by males.

The entire sample population were asked to rank their current hierarchical position in their H&S profession within the survey. The survey had listed out 5 hierarchical positions for the population to choose from. It included, Officer/Supervisor, Engineer, Deputy Manager/Coordinator, Manager/General Manager & General Manager or above. The sample population consisted of 34% subjects at Officer/Supervisor level, 24% subjects at Engineer level, 17% at Deputy Manager/Coordinator level and 22% at Manager/General Manager level. However, only 3% of sample population were from positions above General Manager. Nonetheless, the sample population, to an extent, has enough number of subjects from all the prominent hierarchies of H&S profession to render the collected data as reliable as it comes.

Since one of the exclusion criteria set for the sample population is regarding their experience level in H&S profession for a minimum of 1 year of experience working with both private and public large scale enterprise engaged in construction industry of India, there were obviously 0 subjects with less than 1 year of experience. However, it shall be noted that, in order to satisfy the exclusion criteria, the subject must have had worked either as direct employee or under the clientship of both private and public run large scale enterprises engaged in the construction sector of India for a min period of 1 year. This will in effect, make the minimum working experience required for the subject as a total of 2 years (min of 1 year with public run & min of 1 year of private run).

The survey questionnaire was structured in exactly such a way that the study would be able to omit subjects those haven't had worked a min of 1 year with private run and a min of 1 year with public run enterprise. Out of the 146 original subjects participated in the survey, 42 were omitted as they were not meeting this exclusion criterion.

Furthermore, it shall also be explicitly noted that the 75 subjects who had worked for a period of less than 1 year as an employee in the public run enterprises are not the 07 subjects those have had worked less than 1 year under the clientship of public run enterprises. Conversely, it is quite evident from the data that the 30 subjects who have had worked less than 1 year under the clientship of private run enterprises, have all worked for a min of 1 year as an employee with private run enterprise, as there are zero subjects who haven't had worked as an employee with private run enterprise for a min of 1 year (fig 6).

Another interesting inference from the data is that about 73.5% of the sample population hasn't worked as an employee of a public run (>50% stakes govt owned) large scale enterprise engaged in the construction sector of India, which might lead for this particular group of sample to have limited understanding regarding the H&S management system they had had in place. This could lead to the influx of uninformed or corrupt data into this study. The potential impact of this pitfall is not under the scope of this research and it may very well be considered as one of the limitations of this study.

It is also equally interesting to note that there weren't any single subjects in the whole sample population who haven't had worked for a min of 1 year as an employee with private run large scale enterprises engaged in the construction sector of India.

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Experience	Listed Levels	Frequency	Percentage
Select your span of total working experience* as an occupational H&S professional in the construction industry of India * *consider only large scale enterprises with more than 250 employees*	Less than 1 year	0	0.0%
	1-3 years	12	11.8%
	4-6 years	23	22.5%
	7-10 years	29	28.4%
	Above 10 years	38	37.3%
Select the span of your working experience as an employee (OH&S professional) in public-run enterprises* (>50% stakes govt owned) engaged in the construction industry of India * *consider only large scale enterprises with more than 250 employees*	Less than 1 year	75	73.5%
	1-3 years	9	8.8%
	4-6 years	8	7.8%
	7-10 years	4	3.9%
	Above 10 years	6	5.9%
Select the span of your working experience as a OH&S professional under the clientship of public-run enterprises*(>50% stakes govt owned) engaged in the construction sector of India. * *consider only large scale enterprises with more than 250 employees*	Less than 1 year	7	6.9%
	1-3 years	32	31.4%
	4-6 years	30	29.4%
	7-10 years	18	17.6%
	Above 10 years	15	14.7%
Select the span of your working experience as an employee (OH&S professional) in private-run enterprises* (>50% stakes private owned) engaged in the construction sector of India * *consider only large scale enterprises with more than 250 employees*	Less than 1 year	0	0.0%
	1-3 years	25	24.5%
	4-6 years	28	27.5%
	7-10 years	24	23.5%
	Above 10 years	25	24.5%
Select the span of your working experience as a OH&S professional under the clientship of private-run enterprises* (>50% stakes private owned) engaged in the construction sector of India. * *consider only large scale enterprises with more than 250 employees*	Less than 1 year	30	29.4%
	1-3 years	39	38.2%
	4-6 years	21	20.6%
	7-10 years	8	7.8%
	Above 10 years	4	3.9%

Fig. 6. Data analysis: Experience of sample populace

B. RO1: Comparative analysis between the H&S performance of private and public run enterprises -

The structured questionnaire on H&S management system, developed with reference to ISO 45001:2018 (Figure 1) were presented to all the subjects of the sample population and asked to choose the better performing one according to their personal experience and acquired knowledge.

The data collected (Fig 7) indicated that the private run large scale enterprises engaged in the construction sector of India were having significantly superior H&S management system and thereby better H&S performance. It is also equally interesting to infer that not even a single independent variable or element of H&S management system was performing better for public run enterprise over the private run enterprise.

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Variables	Survey Questionnaire	Frequency for Public run enterprise	Frequency for Private run enterprise
Leadership & commitment	Leadership involvement & commitment over the affairs pertaining to EHS/ OHS in the FIELD/ actual workplace.	18	84
OH&S Policy	OHS/ EHS Policy is formulated, frequently communicated to the employees and more often endorsed by their leaders.	19	83
Organizational roles, responsibilities and authorities	Organizational roles and responsibilities of each employees are well defined and same is clearly communicated with all	23	79
Consultation & participation of workers	Workers Participation & Consultation: The worker representatives are involved in the health and safety committees and their concerns and responses are recorded and valued more.	25	77
Hazard identification & assessment of risks/opportunities	Hazard identification and risk management/ assessment process more effectively developed, followed, practiced, reviewed, continuously improved and that all activities are commenced in the field after conducting a risk assessment	23	79
Determination of legal requirements	All the applicable legal requirements pertaining to EHS/OHS are identified and documented and the periodic review of the same against the level of compliance of the organization is carried out. Legal register is regularly updated, as needed too.	27	75
Planning action			
OH&S objectives	EHS Objectives and KPI targets well formulated, continuously tracked and periodically reviewed for its achievability	22	80
Planning to achieve OH&S objectives			
Resources	Resources: The organization has identified, allocated sufficient budgets and delivered all the required resources needed for the establishment, implementation, maintenance and continual improvement of the H&S management system.	24	78
Competence	Training & competence : Training on the affairs pertaining to the EHS/ OHS to be happening in a systemic way, in pre-planned time intervals to all the employees from all the departments and the entailing competency assessment protocols	26	76
Awareness	EHS awareness programs are periodically carried out involving all employees (campaigns, competitions, exhibitions, newsletters, flyers etc.)	26	76

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Communication (Internal & External)	A comprehensive, controlled system is developed and implemented to share relevant information pertaining to EHS with both internal and external stakeholders of the organization	26	76
Documented information (Creation, updation & control)	Comprehensive and standardized EHS/ OHS document management system, with a clear minimum requirement for the document types and a set time for its periodic review and that all of these documents are made accessible to all the employees in the organization.	27	75
Elimination of hazards & reducing risks	Implementation of their own EHS/ OHS procedures, manuals, control measures from risk assessments are more visible and apparent in the field.	25	77
	OH&S inspection regime for all system, tools and equipment are well developed, documented and exercised as a cross functional drive with participation of authorized people from concerned departments and that the results of all these inspections are recorded and made accessible to all the concerned employees.	24	78
Management of change	A comprehensive plan is developed to control and manage all kinds of changes that can impact the EHS performance of the organization	23	79
Procurement	Contractor selection and outsourcing process well-developed, documented, implemented and continuously exercised, updated and reviewed.	25	77
Emergency preparedness & response	Emergency preparedness and response well developed, documented, implemented, exercised and continuously improved for all kinds of probable emergency scenarios	28	74
Monitoring and performance evaluation	Individual performance of all the employees over the level of EHS compliance is periodically evaluated, appraised and rewarded/ reprimanded in a systematic manner and recorded.	19	83
Evaluation of compliance			
Internal audit	Health and Safety Audits (First party & Third Party) happening in a systematic way in fixed intervals in a transparent and effective manner along with a comprehensive system facilitating the management review to follow up all the corrective and preventive actions aimed at continuous improvement	29	73
Management review			
Incident, non-conformity and corrective action	Continual improvement process is well developed, exercised and that all the corrective as well as preventive actions identified from all EHS violations, incident investigations, root cause analysis, audits are recorded along with a well-defined action plan with clear identity of people accountable & target dates. This is also ensued by follow- up evaluations to ensure the effectiveness of its implementation.	27	75
Continual improvement			

Fig. 7. Data analysis: frequency table for survey response

C. Cronbach's alpha (Reliability analysis) -

Reliability is often considered as the ability of an instrument to measure consistently and it is dearly associated with its validity, as an instrument cannot be possibly valid unless it is reliable [57]. The test results returned indicates a high Cronbach alpha value (0.972) rendering the questionnaire statistics highly reliable for further extrapolation (Fig 8).

Also, the value for cronbach's alpha was found to be not going below 0.9 in all events, where any one of the twenty variables were to be deleted, which again substantiates the internal consistency of the variables and the reliability of the questionnaire (Fig 9).

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Case Processing Summary

		N	%
Cases	Valid	102	100.0
	Excluded [a]	0	.0
	Total	102	100.0

a. Listwise deletion based on all variables in the procedure.

Reliability Statistics

Cronbach's Alpha	N of Items
.972	20

Fig. 8. Cronbach's alpha (a)

Item-Total Statistics

	Scale Mean if Item Deleted	Scale Variance if Item Deleted	Corrected Item-Total Correlation	Cronbach's Alpha if Item Deleted
Leadership & commitment	33.4118	44.126	0.636	0.972
OH&S Policy	33.4216	43.454	0.756	0.971
Organizational roles, responsibilities and authorities	33.4608	43.419	0.707	0.971
Consultation & participation of workers	33.4804	42.906	0.78	0.97
Hazard identification & assessment of risks/opportunities	33.4608	42.746	0.835	0.97
Determination of legal requirements & Planning action	33.5	42.728	0.791	0.97
OH&S objectives & Planning to achieve them	33.451	42.904	0.819	0.97
OH&S Resources	33.4706	42.786	0.814	0.97
OH&S Competence	33.4902	43.401	0.679	0.971
OH&S Awareness	33.4902	42.965	0.758	0.971
OH&S Communication (Internal & External)	33.4902	43.203	0.715	0.971
Documented OH&S information (Creation, updation & control)	33.5	42.431	0.845	0.97
Elimination of hazards & reducing risks (Implementation of EHS/OHS procedures, manuals, control measures from RA)	33.4804	42.628	0.831	0.97
Elimination of hazards & reducing risks (OH&S Inspection regimes)	33.4706	42.529	0.863	0.97
Management of change	33.4608	42.845	0.816	0.97
Procurement	33.4804	42.807	0.798	0.97
Emergency preparedness & response	33.5098	42.846	0.76	0.971
Monitoring and performance evaluation & Evaluation of compliance	33.4216	42.86	0.877	0.969
Internal audit & Management review	33.5196	42.47	0.818	0.97
Incident, non-conformity and corrective action & Continual Improvement	33.5	42.748	0.787	0.97

Fig. 9. Cronbach's alpha (b)

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D. KMO and Bartlett's test (Validity Analysis) -

The structure validity of the questionnaire was analyzed by running the Kaiser-Meyer-Olkin(KMO) and Bartlett test, which yielded the results of KMO 0.889, which is above 0.8. In addition, the p value was found to be reporting <0.001, which is less than 0.05. All of this indicates the high structural validity of the questionnaire data (Fig 10).

KMO and Bartlett's Test

Kaiser-Meyer-Olkin Measure of Sampling Adequacy.		.889
Bartlett's Test of Sphericity	Approx. Chi-Square	2310.112
	df	190
	Sig.	<.001

Fig. 10. KMO & Bartletts

E. Leadership & commitment (Variable 1) : Runs Test -

Runs tests were run across the entire set of dichotomous variables that form part of the non-parametric data set which addresses the primary research objective, in order to ensure the random distribution of the data and the lack of bias within.

It shall be noted that the runs test was executed after assigning value 1 for public run enterprise and 2 for private run enterprise, which will give us the custom reference mean(μ) of 1.5.

H0(Null): The data collected is following a random distribution and exhibits no bias within.

H1 (Alternate): The data collected is not randomly distributed and there is bias within.

Descriptive Statistics

	N	Mean	Std. Deviation	Minimum	Maximum
Leadership & commitment	102	1.8235	.38310	1.00	2.00

Runs Test

	Leadership & commitment
Test Value[a]	2.00
Cases < Test Value	18
Cases >= Test Value	84
Total Cases	102
Number of Runs	33
Z	.811
Asymp. Sig. (2-tailed)	.417

a. Median

Fig. 11. Runs test

Since the obtained value of significance (p) is 0.417 and is greater than 0.05 (p > 0.05), H0 is not rejected, data is randomly distributed and devoid of bias (Fig 11).

F. Leadership & commitment (Variable 1) : Binomiual testing/ Hypothesis testing -

The hypothesis testing employed for sake of statistical extrapolation was Binomial test as the researcher found it most suitable for the one-sample data set that is nonparametric in nature. Binomial test measures the distribution of values is binomial or not and the binomial distribution assumes that any outcome is equally distributed (p = 0.05).

H0(Null): The H&S performance in terms of leadership and commitment of public run (>50% stakes owned by govt) and private run enterprises engaged in the construction sector of India is same and equal (proves the binomial assumption of equal probability)

H1 (Alternate): There is a significant difference in the H&S performance in terms of leadership and commitment between

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the public run (>50% stakes owned by govt) and private run enterprises engaged in the construction sector of India (negates the binomial assumption of equal probability).

Binomial Test

		Category	N	Observed Prop.	Test Prop.	Exact Sig. (2-tailed)
Leadership & commitment	Group 1	Private run enterprise	84	.82	.50	<.001
	Group 2	Public run enterprise	18	.18		
	Total		102	1.00		

Fig. 12. Binomial test Runs test

The obtained value of significance (p) is <0.001 and is lower than 0.05 (Fig 12). The null hypothesis is thereby rejected and the results indicates there is a is a significant difference in the H&S performance between the public run (>50% stakes owned by govt) and private run enterprises engaged in the construction sector of India. Similarly, all these tests were separately done on 20 independent variables and the results are tabulated in Figures 13, 14 & 15.

Sl. No.	Variables	DESCRIPTIVE STATISTICS				
		N	Mean	Standard Deviation	Min.	Max.
1	Leadership & commitment	102	1.8235	0.3831	1	2
2	OH&S Policy	102	1.8137	0.39125	1	2
3	Organizational roles, responsibilities	102	1.7745	0.41997	1	2
4	Consultation & participation of workers	102	1.7549	0.43227	1	2
5	Hazard identification & risk management	102	1.7745	0.41997	1	2
6	Legal requirements	102	1.7353	0.44336	1	2
7	OH&S objectives	102	1.7843	0.41333	1	2
8	H&S Resources	102	1.7647	0.42628	1	2
9	Training & Competence	102	1.7451	0.43796	1	2
10	H&S awareness programs	102	1.7451	0.43796	1	2
11	Communication (Internal & External)	102	1.7451	0.43796	1	2
12	Documented information (Creation, updation & control)	102	1.7353	0.44336	1	2
13	Implementation of OH&S procedure/ manuals/ control measures from risk assessments etc. in the field	102	1.7549	0.43227	1	2
14	OH&S inspection regimes	102	1.7647	0.42628	1	2
15	Management of change	102	1.7745	0.41997	1	2
16	Contractor selection	102	1.7549	0.43227	1	2
17	Emergency preparedness & response	102	1.7255	0.44847	1	2
18	Monitoring and performance evaluation	102	1.8137	0.39125	1	2
19	Audits	102	1.7157	0.45331	1	2
20	Continual improvement from OH&S violations, incidents, RCA, lessons learned etc.	102	1.7353	0.44336	1	2

Fig. 13. Descriptive statistics for all variables

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Sl. No.	Variables	RUNS TEST (Custom mean = 1.5)				*Result Interpretation*
		Total Cases	Num of Runs	Mean μ	Asymp. Sig. (2-tailed)	
1	Leadership & commitment	102	33	1.8235	0.417	p > 0.05, H0 is not rejected, data is randomly distributed and devoid of bias
2	OH&S Policy	102	37	1.8137	0.093	p > 0.05, H0 is not rejected, data is randomly distributed and devoid of bias
3	Organizational roles, responsibilities	102	37	1.7745	0.915	p > 0.05, H0 is not rejected, data is randomly distributed and devoid of bias
4	Consultation & participation of workers	102	40	1.7549	0.735	p > 0.05, H0 is not rejected, data is randomly distributed and devoid of bias
5	Hazard identification & risk management	102	33	1.7745	0.299	p > 0.05, H0 is not rejected, data is randomly distributed and devoid of bias
6	Legal requirements	102	43	1.7353	0.556	p > 0.05, H0 is not rejected, data is randomly distributed and devoid of bias
7	OH&S objectives	102	39	1.7843	0.302	p > 0.05, H0 is not rejected, data is randomly distributed and devoid of bias
8	H&S Resources	102	37	1.7647	0.845	p > 0.05, H0 is not rejected, data is randomly distributed and devoid of bias
9	Training & Competence	102	45	1.7451	0.167	p > 0.05, H0 is not rejected, data is randomly distributed and devoid of bias
10	H&S awareness programs	102	36	1.7451	0.325	p > 0.05, H0 is not rejected, data is randomly distributed and devoid of bias

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11	Communication (Internal & External)	102	39	1.7451	0.845	p > 0.05, H0 is not rejected, data is randomly distributed and devoid of bias
12	Documented information (Creation, updation & control)	102	41	1.7353	0.94	p > 0.05, H0 is not rejected, data is randomly distributed and devoid of bias
13	Implementation of OH&S procedure/ manuals/ control measures from risk assessments etc. in the field	102	41	1.7549	0.543	p > 0.05, H0 is not rejected, data is randomly distributed and devoid of bias
14	OH&S inspection regimes	102	35	1.7647	0.453	p > 0.05, H0 is not rejected, data is randomly distributed and devoid of bias
15	Management of change	102	33	1.7745	0.299	p > 0.05, H0 is not rejected, data is randomly distributed and devoid of bias
16	Contractor selection	102	43	1.7549	0.251	p > 0.05, H0 is not rejected, data is randomly distributed and devoid of bias
17	Emergency preparedness & response	102	43	1.7255	0.731	p > 0.05, H0 is not rejected, data is randomly distributed and devoid of bias
18	Monitoring and performance evaluation	102	31	1.8137	0.761	p > 0.05, H0 is not rejected, data is randomly distributed and devoid of bias
19	Audits	102	47	1.7157	0.271	p > 0.05, H0 is not rejected, data is randomly distributed and devoid of bias
20	Continual improvement from OH&S violations, incidents, RCA, lessons learned etc.	102	47	1.7353	0.107	p > 0.05, H0 is not rejected, data is randomly distributed and devoid of bias

Fig. 14. Runs test for all variables

Sl. No.	Variables	BINOMIAL TEST (Test Prop. = 0.50)					*Result Interpretation*
		Private run (N)	Public run (N)	Observed Prop. (Private)	Observed Prop. (Public)	Exact. Sig. (2-tailed)	
1	Leadership & commitment	84	18	0.811	0.18	<0.001	p < 0.001, lower than 0.5: null hypothesis is not accepted, significant difference in H&S performance between public and private run
2	OH&S Policy	83	19	0.81	0.19	<0.001	p < 0.001, lower than 0.5: null hypothesis is not accepted, significant difference in H&S performance between public and private run
3	Organizational roles, responsibilities	79	23	0.77	0.23	<0.001	p < 0.001, lower than 0.5: null hypothesis is not accepted, significant difference in H&S performance between public and private run
4	Consultation & participation of workers	77	25	0.75	0.25	<0.001	p < 0.001, lower than 0.5: null hypothesis is not accepted, significant difference in H&S performance between public and private run
5	Hazard identification & risk management	79	23	0.77	0.23	<0.001	p < 0.001, lower than 0.5: null hypothesis is not accepted, significant difference in H&S performance between public and private run
6	Legal requirements	75	27	0.74	0.26	<0.001	p < 0.001, lower than 0.5: null hypothesis is not accepted, significant difference in H&S performance between public and private run
7	OH&S objectives	80	22	0.78	0.22	<0.001	p < 0.001, lower than 0.5: null hypothesis is not accepted, significant difference in H&S performance between public and private run
8	H&S Resources	78	24	0.76	0.24	<0.001	p < 0.001, lower than 0.5: null hypothesis is not accepted, significant difference in H&S performance between public and private run

9	Training & Competence	76	26	0.75	0.25	<0.001	$p < 0.001$, lower than 0.5: null hypothesis is not accepted, significant difference in H&S performance between public and private run
10	H&S awareness programs	76	26	0.75	0.25	<0.001	$p < 0.001$, lower than 0.5: null hypothesis is not accepted, significant difference in H&S performance between public and private run
11	Communication (Internal & External)	76	26	0.75	0.25	<0.001	$p < 0.001$, lower than 0.5: null hypothesis is not accepted, significant difference in H&S performance between public and private run
12	Documented information (Creation, updation & control)	75	27	0.74	0.26	<0.001	$p < 0.001$, lower than 0.5: null hypothesis is not accepted, significant difference in H&S performance between public and private run
13	Implementation of OH&S procedure/ manuals/ control measures from risk assessments etc. in the field	77	25	0.75	0.25	<0.001	$p < 0.001$, lower than 0.5: null hypothesis is not accepted, significant difference in H&S performance between public and private run
14	OH&S inspection regimes	78	24	0.76	0.24	<0.001	$p < 0.001$, lower than 0.5: null hypothesis is not accepted, significant difference in H&S performance between public and private run
15	Management of change	79	23	0.77	0.23	<0.001	$p < 0.001$, lower than 0.5: null hypothesis is not accepted, significant difference in H&S performance between public and private run
16	Contractor selection	77	25	0.75	0.25	<0.001	$p < 0.001$, lower than 0.5: null hypothesis is not accepted, significant difference in H&S performance between public and private run
17	Emergency preparedness & response	74	28	0.73	0.27	<0.001	$p < 0.001$, lower than 0.5: null hypothesis is not accepted, significant difference in H&S performance between public and private run

18	Monitoring and performance evaluation	83	19	0.81	0.19	<0.001	p < 0.001, lower than 0.5: null hypothesis is not accepted, significant difference in H&S performance between public and private run
19	Audits	73	29	0.72	0.28	<0.001	p < 0.001, lower than 0.5: null hypothesis is not accepted, significant difference in H&S performance between public and private run
20	Continual improvement from OH&S violations, incidents, RCA, lessons learned etc.	75	27	0.74	0.26	<0.001	p < 0.001, lower than 0.5: null hypothesis is not accepted, significant difference in H&S performance between public and private run

Fig. 15. Binomial test for all variables

The collective results from all the binomial tests indicates that there is a there is a significant difference in terms H&S performance between the public and private run enterprises, as for all 20 variables, p value was lesser than 0.05.
Now, the mean(μ) reported from the runs tests, run with all the individual variables which dictates the H&S performance in an organization is greater than the custom reference mean of 1.5, where 1 was assigned to public run and 2 was assigned to private run enterprises (the scale of measurement was set as ordinal). This explicitly indicates that the H&S performance of private run enterprises is significantly greater than the public run (>50% stakes owned by govt) large scale enterprises engaged in the construction sector of India.

G. RO 2: Scope for improvement in H&S performance for both private and public run enterprises and the relationship between the two over the same -

The sample populace was asked to choose the top 3 elements of H&S management system they find in both private and public run large scale enterprises engaged in the construction sector of India to be improved significantly and in a priority basis (1st, 2nd and 3rd). All the variables of the study were listed out for the subjects to choose from, thusly avoiding the accumulation of random inputs. Prudence was ensured to program the survey not to accept the variables, if they were repeated elsewhere in the order of top 3 priorities.
Additionally, for sake of easiness in extrapolation and running the inferential tests, all twenty variables were grouped into 6 parent groups, in accordance with ISO 45001:2018 and Figure 4.

H. Cronbach's alpha (Reliability analysis) -

The test results returned indicates a high Cronbach alpha value (0.802) rendering the questionnaire statistics highly reliable for further extrapolation (Fig 16).

Also, the value for Cronbach's alpha was found to be not going below 0.7 in all events, where any one of the twenty variables were to be deleted, which again substantiates the internal consistency of the variables and the reliability of the questionnaire (Fig 17).

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Case Processing Summary

		N	%
Cases	Valid	102	100.0
	Excluded[a]	0	.0
	Total	102	100.0

a. Listwise deletion based on all variables in the procedure.

Reliability Statistics

Cronbach's Alpha	N of Items
.802	6

Fig. 16. Cronbach alpha (a) (RO2)

Item-Total Statistics

	Scale Mean if Item Deleted	Scale Variance if Item Deleted	Corrected Item-Total Correlation	Cronbach's Alpha if Item Deleted
Scope for Improvement (1st Priority) : Elements of OHSMS where the large scale private run enterprises engaged in the construction sector of India.	22.4706	285.420	.413	.802
Scope for Improvement (2nd Priority) : Elements of OHSMS where the large scale private run enterprises engaged in the construction sector of India.	21.7255	265.587	.673	.753
Scope for Improvement (3rd Priority) : Elements of OHSMS where the large scale private run enterprises engaged in the construction sector of India.	20.2549	243.598	.498	.794
Scope for Improvement (1st Priority) : Elements of OHSMS where the large scale public run enterprises engaged in the construction sector of India.	22.4804	281.282	.467	.791
Scope for Improvement (2nd Priority) : Elements of OHSMS where the large scale public run enterprises engaged in the construction sector of India.	21.5686	250.129	.711	.740
Scope for Improvement (3rd Priority) : Elements of OHSMS where the large scale public run enterprises engaged in the construction sector of India.	20.1275	227.439	.668	.745

Fig. 17. Cronbach alpha (b) (RO2)

I. KMO and Bartlett's test (Validity Analysis) -

The structure validity of the questionnaire was analyzed by running the Kaiser-Meyer-Olkin(KMO) and Bartlett test, which yielded the results of KMO 0.680, which is above 0.6 and can be considered acceptable [60]. In addition, the p value was found to be reporting <0.001, which is less than 0.05. All of this indicates the high structural validity of the questionnaire data (Fig 18).

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KMO and Bartlett's Test

Kaiser-Meyer-Olkin Measure of Sampling Adequacy.		.680
Bartlett's Test of Sphericity	Approx. Chi-Square	232.659
	df	15
	Sig.	<.001

Fig. 18. KMO & Bartletts (RO2)

J. Scope for improvement : 1st priorities -

The frequency table (Fig 19) clearly indicates that the parent group variable of leadership & worker participation is the most frequent (80.4%) 1st priority for the scope for improvement in H&S performance of private run enterprises.

Now, the further break-up of top frequent parent group variable of leadership & worker participation indicates that nearly 52.4% was frequented by leadership & commitment, 32.9% frequented by OH&S policy, 13.4% by organizational roles & responsibilities and 1.2% by consultation & participation of workers.

Variables for scope for improvement (1st priority) in private run enterprises	1st Priority (frequency)	Parent group Variables	1st Priority (frequency)	Valid Percentage	Cumulative Percentage
Leadership & commitment	43	Leadership & Worker participation	82	80.4	80.4
OH&S Policy	27				
Organizational roles, responsibilities	11				
Consultation & participation of workers	1				
Hazard identification & risk management	5	Planning	9	8.8	89.2
Legal requirements	4				
OH&S objectives	0				
H&S resources	1	Support	4	3.9	93.1
Training & Competence	2				
H&S awareness	1				
Communication (internal & external)	0				
Documented information (creation, updation & control)	0				
Implementation of EHS/OHS procedures, manuals, control measures from RA in the field	3	Operation	4	3.9	97.1
OH&S Inspection regimes	0				
Management of change	0				
Contractor selection	1				
Emergency preparedness & response	0				
Monitoring and performance evaluation	1	Performance evaluation	1	1	98
Audits	0				
Continual improvement from OH&S violations, incidents, RCA, lessons learned etc.	2	Improvement	2	2	100
Total	102		102	100	

Fig. 19. Frequency table for 1st priority (private)

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The frequency table (Table 20) clearly indicates that the parent group variable of leadership & worker participation is the most frequent (82.4%) 1st priority for the scope for improvement in H&S performance of public run enterprises.
Now, the further break-up of top frequent parent group variable of leadership & worker participation indicates that nearly 48.8% was frequented by leadership & commitment, 29.8% frequented by OH&S policy, 19.0% by organizational roles & responsibilities and 2.4% by consultation & participation of workers

Variables for scope for improvement (1st priority) in public run enterprises	1st Priority (frequency)	Parent group Variables	1st Priority (frequency)	Valid Percentage	Cumulative Percentage
Leadership & commitment	41	Leadership & Worker participation	84	82.4	82.4
OH&S Policy	25				
Organizational roles, responsibilities	16				
Consultation & participation of workers	2				
Hazard identification & risk management	1	Planning	7	6.9	89.2
Legal requirements	5				
OH&S objectives	1				
H&S resources	4	Support	5	4.9	94.1
Training & Competence	1				
H&S awareness	0				
Communication (internal & external)	0				
Documented information (creation, updation & contro	0				
Implementation of EHS/OHS procedures, manuals, control measures from RA in the field	1	Operation	4	3.9	98
OH&S Inspection regimes	0				
Management of change	1				
Contractor selection	1				
Emergency preparedness & response	1				
Monitoring and performance evaluation	0	Performance evaluation	0	0	0
Audits	0				
Continual improvement from OH&S violations, incidents, RCA, lessons learned etc.	2	Improvement	2	2.00	100.00
Total	102		102	100	

Fig. 20. Frequency table for 1st priority (public)

K. Relationship between the scope for improvement (1st priority) for private and public run enterprises -

The chi square test of independence is used to assess the relationship between two variables and thereby, it is a correlation analysis for a nominal/ ordinal data. It is generally employed to test the hypothesis that two categorical variables are independent of each other. A relatively smaller chi-square statistic indicates that the null hypothesis is correct and the two variables are independent of each other. Conversely, a higher chi-square statistic would indicate that the two variables are not independent, rather associated with each other.
As the chi square test of independence can be run between two variables at a time, the analysis was done in 3 stages, with individuals test for 1st priority, 2nd priority and 3rd priority for the scope for improvement for H&S performance for public-run and private run enterprises, as chosen by the subjects of sample populace.

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Null hypothesis(H0): There is no association between the scope for improvement for H&S performance between private and public run enterprises.

Scope for Improvement (1st Priority): Elements of OHSMS where the large scale private run enterprises engaged in the construction sector of India. * Scope for Improvement (1st Priority): Elements of OHSMS where the large scale public run enterprises engaged in the construction sector of India.								
CROSS TABULATION								
			Scope for Improvement (1st Priority) : Elements of OHSMS where the large scale public run enterprises engaged in the construction sector of India ***(Y axis).***					Total
			Leadership & worker participation	Planning	Support	Operation	Improvement	
Scope for Improvement (1st Priority) : Elements of OHSMS where the large scale private run enterprises engaged in the construction sector of India ***(X axis).***	Leadership & worker participation	Count	75	2	3	2	0	82
		Expected Count	67.5	5.6	4	3.2	1.6	82
		% within (X axis)	91.50%	2.40%	3.70%	2.40%	0.00%	100.00%
	Planning	Count	4	3	0	2	0	9
		Expected Count	7.4	0.6	0.4	0.4	0.2	9
		% within (X axis)	44.40%	33.30%	0.00%	22.20%	0.00%	100.00%
	Support	Count	1	1	1	0	1	4
		Expected Count	3.3	0.3	0.2	0.2	0.1	4
		% within (X axis)	25.00%	25.00%	25.00%	0.00%	25.00%	100.00%
	Operation	Count	2	1	1	0	0	4
		Expected Count	3.3	0.3	0.2	0.2	0.1	4
		% within (X axis)	50.00%	25.00%	25.00%	0.00%	0.00%	100.00%
	Performance evaluation	Count	0	0	0	0	1	1
		Expected Count	0.8	0.1	0	0	0	1
		% within (X axis)	0.00%	0.00%	0.00%	0.00%	100.00%	100.00%
	Improvement	Count	2	0	0	0	0	2
		Expected Count	1.6	0.1	0.1	0.1	0	2
		% within (X axis)	100.00%	0.00%	0.00%	0.00%	0.00%	100.00%
Total		Count	84	7	5	4	2	102
		Expected Count	84	7	5	4	2	102
		% within (X axis)	82.40%	6.90%	4.90%	3.90%	2.00%	100.00%

Fig. 21. Cross tabulation for 1st priorities

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Chi-Square Tests

	Value	df	Asymptotic Significance (2-sided)	Exact Sig. (2-sided)	Exact Sig. (1-sided)	Point Probability
Pearson Chi-Square	98.736[a]	20	<.001	<.001		
Likelihood Ratio	40.472	20	.004	<.001		
Fisher-Freeman-Halton Exact Test	55.288			<.001		
Linear-by-Linear Association	13.342[b]	1	<.001	.002	.002	.000
N of Valid Cases	102					

a. 27 cells (90.0%) have expected count less than 5. The minimum expected count is .02.

b. The standardized statistic is 3.653.

Fig. 22. Chi square tests for 1st priorities

The requisite for running a successful chi square which demands the presence of minimum 5 counts in all cells of the crosstab matrix was failed in the case, as 27 cells in the crosstabs had values less than 5 (Fig 22). Hence, the Fisher-Freeman-Halton Exact test was executed to gather the significance value. The significance value for N=102 (Fig 21), reported was <0.001, which is less than 0.05. Since reported P value was less than 0.05, the null hypothesis was rejected. Post hoc tests were run as a follow up analysis to delve deeper into the degree of association/dependence between the scope for improvement (1st priority) for private and public run enterprises. The Bonferroni correction factor obtained was 0.001667 (0.05/30 i.e., Number of comparisons).

Scope for Improvement (1st Priority): Elements of OHSMS where the large scale private run enterprises engaged in the construction sector of India. * Scope for Improvement (1st Priority): Elements of OHSMS where the large scale public run enterprises engaged in the construction sector of India.
CROSS TABULATION

			Scope for Improvement (1st Priority) : Elements of OHSMS where the large scale public run enterprises engaged in the construction sector of India *(Y axis)*.				
			Leadership & worker participation	Planning	Support	Operation	Improvement
Scope for Improvement (1st Priority) : Elements of OHSMS where the large scale private run enterprises engaged in the construction sector of India *(X axis)*.	Leadership & worker participation	Count	75	2	3	2	0
		Expected Count	67.5	5.6	4.0	3.2	1.6
		% within *X axis*	91.5%	2.4%	3.7%	2.4%	0.0%
		Adjusted Residual	4.9	-3.6	-1.2	-1.6	-2.9
		Calculated P value	0.000	0.000	0.239	0.118	0.004
		Significance (comparing with Bonferroni correction factor)	Significant	Significant			
	Planning	Count	4	3	0	2	0
		Expected Count	7.4	0.6	0.4	0.4	0.2
		% within *X axis*	44.4%	33.3%	0.0%	22.2%	0.0%
		Adjusted Residual	-3.1	3.3	-0.7	3.0	-0.4
		Calculated P value	0.002	0.0010	0.476	0.003	0.657
		Significance (comparing with Bonferroni correction factor)		Significant			

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	Support	Count	1	1	1	0	1
		Expected Count	3.3	0.3	0.2	0.2	0.1
		% within *X axis*	25.0%	25.0%	25.0%	0.0%	25.0%
		Adjusted Residual	-3.1	1.5	1.9	-0.4	3.4
		Calculated P value	0.002	0.143	0.058	0.680	0.0007
		Significance (comparing with Bonferroni correction factor)					Significant
	Operation	Count	2	1	1	0	0
		Expected Count	3.3	0.3	0.2	0.2	0.1
		% within *X axis*	50.0%	25.0%	25.0%	0.0%	0.0%
		Adjusted Residual	-1.7	1.5	1.9	-0.4	-0.3
		Calculated P value	0.083	0.143	0.058	0.680	0.773
		Significance (comparing with Bonferroni correction factor)					
	Performance evaluation	Count	0	0	0	0	1
		Expected Count	0.8	0.1	0.0	0.0	0.0
		% within *X axis*	0.0%	0.0%	0.0%	0.0%	100.0%
		Adjusted Residual	-2.2	-0.3	-0.2	-0.2	7.1
		Calculated P value	0.030	0.785	0.820	0.839	0.0000
		Significance (comparing with Bonferroni correction factor)					Significant
	Improvement	Count	2	0	0	0	0
		Expected Count	1.6	0.1	0.1	0.1	0.0
		% within *X axis*	100.0%	0.0%	0.0%	0.0%	0.0%
		Adjusted Residual	0.7	-0.4	-0.3	-0.3	-0.2
		Calculated P value	0.509	0.698	0.746	0.773	0.840
		Significance (comparing with Bonferroni correction factor)					

Fig. 23. Cross tabulation with bonferroni correction factor (1st priorities)

The significant degree of association/dependence of scope for improvement (1st priority) between public run and private run enterprises were identified precisely between leadership/worker participation(public) and leadership/worker participation(private), planning(public) and leadership/worker participation(private), planning(public) and planning(private), improvement(public) and support(private) and lastly, improvement(public) and performance evaluation(private) (Fig 23).

L. Scope for improvement: 2nd priorities -

The frequency table (Fig 24) clearly indicates that the parent group variable of leadership & worker participation is the most frequent (73.5%) 1st priority for the scope for improvement in H&S performance of private run enterprises.

Now, the further break-up of top frequent parent group variable of leadership & worker participation indicates that nearly 26.7% was frequented by leadership & commitment, 33.3% frequented by OH&S policy, 32% by organizational roles & responsibilities and 8% by consultation & participation of workers.

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Variables for scope for improvement (2nd priority) in private run enterprises	2nd Priority (frequency)	Parent group Variables	2nd Priority (frequency)	Valid Percentage	Cumulative Percentage
Leadership & commitment	20	Leadership & Worker participation	75	73.5	73.5
OH&S Policy	25				
Organizational roles, responsibilities	24				
Consultation & participation of workers	6				
Hazard identification & risk management	4	Planning	12	11.8	85.3
Legal requirements	6				
OH&S objectives	2				
H&S resources	1	Support	11	10.8	96.1
Training & Competence	6				
H&S awareness	1				
Communication (internal & external)	0				
Documented information (creation, updation & control)	3				
Implementation of EHS/OHS procedures, manuals, control measures from RA in the field	1	Operation	3	2.9	99
OH&S Inspection regimes	0				
Management of change	0				
Contractor selection	2				
Emergency preparedness & response	0				
Monitoring and performance evaluation	0	Performance evaluation	1	1	100
Audits	1				
Continual improvement from OH&S violations, incidents, RCA, lessons learned etc.	0	Improvement	0	0	0
Total	102		102	100	

Fig. 24. Frequency table for 2nd priority (private)

The frequency table (Fig 25) clearly indicates that the parent group variable of leadership & worker participation is the most frequent (78%) 1st priority for the scope for improvement in H&S performance of public run enterprises.

Now, the further break-up of top frequent parent group variable of leadership & worker participation indicates that nearly 24.4% was frequented by leadership & commitment, 34.6% frequented by OH&S policy, 30.8% by organizational roles & responsibilities and 10.3% by consultation & participation of workers.

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Variables for scope for improvement (2nd priority) in public run enterprises	2nd Priority (frequency)	Parent group Variables	2nd Priority (frequency)	Valid Percentage	Cumulative Percentage
Leadership & commitment	19	Leadership & Worker participation	78	76.5	76.5
OH&S Policy	27				
Organizational roles, responsibilities	24				
Consultation & participation of workers	8				
Hazard identification & risk management	2	Planning	8	7.8	84.3
Legal requirements	5				
OH&S objectives	1				
H&S resources	2	Support	10	9.8	94.1
Training & Competence	1				
H&S awareness	4				
Communication (internal & external)	1				
Documented information (creation, updation & contro	2				
Implementation of EHS/OHS procedures, manuals, control measures from RA in the field	0	Operation	3	2.9	97.1
OH&S Inspection regimes	1				
Management of change	0				
Contractor selection	2				
Emergency preparedness & response	0				
Monitoring and performance evaluation	3	Performance evaluation	3	2.9	100
Audits	0				
Continual improvement from OH&S violations, incidents, RCA, lessons learned etc.	0	Improvement	0	0	0
Total	102		102	100	

Fig. 25. Frequency table for 2nd priority (public)

M. Relationship between the scope for improvement (2nd priority) for private and public run enterprises -

Null hypothesis(H0): There is no association between the scope for improvement for H&S performance between private and public run enterprises.

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Scope for Improvement (2nd Priority): Elements of OHSMS where the large scale private run enterprises engaged in the construction sector of India. * Scope for Improvement (2nd Priority): Elements of OHSMS where the large scale public run enterprises engaged in the construction sector of India.								
CROSS TABULATION								
			Scope for Improvement (2nd Priority) : Elements of OHSMS where the large scale public run enterprises engaged in the construction sector of India ***(Y axis)*** .					Total
			Leadership & worker participation	Planning	Support	Operation	Performance evaluation	
Scope for Improvement (2nd Priority) : Elements of OHSMS where the large scale private run enterprises engaged in the construction sector of India ***(X axis).***	Leadership & worker participation	Count	66	7	1	1	0	75
		Expected Count	57.4	5.9	7.4	2.2	2.2	75
		% within (X axis)	88.00%	9.30%	1.30%	1.30%	0.00%	100.00%
	Planning	Count	9	0	2	1	0	12
		Expected Count	9.2	0.9	1.2	0.4	0.4	12
		% within (X axis)	75.00%	0.00%	16.70%	8.30%	0.00%	100.00%
	Support	Count	3	1	6	0	1	11
		Expected Count	8.4	0.9	1.1	0.3	0.3	11
		% within (X axis)	27.30%	9.10%	54.50%	0.00%	9.10%	100.00%
	Operation	Count	0	0	1	1	1	3
		Expected Count	2.3	0.2	0.3	0.1	0.1	3
		% within (X axis)	0.00%	0.00%	33.30%	33.30%	33.30%	100.00%
	Performance evaluation	Count	0	0	0	0	1	1
		Expected Count	0.8	0.1	0.1	0	0	1
		% within (X axis)	0.00%	0.00%	0.00%	0.00%	100.00%	100.00%
Total		Count	78	8	10	3	3	102
		Expected Count	78	8	10	3	3	102
		% within (X axis)	76.50%	7.80%	9.80%	2.90%	2.90%	100.00%

Fig. 26. Cross tabulation for 2nd priorities

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Chi-Square Tests

	Value	df	Asymptotic Significance (2-sided)	Exact Sig. (2-sided)	Exact Sig. (1-sided)	Point Probability
Pearson Chi-Square	96.699[a]	16	<.001	<.001		
Likelihood Ratio	55.428	16	<.001	<.001		
Fisher-Freeman-Halton Exact Test	59.688			<.001		
Linear-by-Linear Association	49.532[b]	1	<.001	<.001	<.001	.000
N of Valid Cases	102					

a. 20 cells (80.0%) have expected count less than 5. The minimum expected count is .03.

b. The standardized statistic is 7.038.

Fig. 27. Chi square tests for 2nd priorities

The requisite for running a successful chi square which demands the presence of minimum 5 values in all cells of the crosstab matrix was failed in the case, as 20 cells in the crosstabs had values less than 5. Hence, the Fisher-Freeman-Halton Exact test was executed to gather the significance value. The significance value for N=102 (Fig 26), reported was <0.001, which is less than 0.05 (Fig 27). Since reported P value was less than 0.05, the null hypothesis was rejected. Post hoc tests were run as a follow up analysis to delve deeper into the degree of association/dependence between the scope for improvement (2nd priority) for private and public run enterprises. The Bonferroni correction factor obtained was 0.0020 (0.05/25 i.e., Number of comparisons).

Scope for Improvement (2nd Priority): Elements of OHSMS where the large scale private run enterprises engaged in the construction sector of India. * Scope for Improvement (2nd Priority): Elements of OHSMS where the large scale public run enterprises engaged in the construction sector of India.
CROSS TABULATION

			Scope for Improvement (2nd Priority) : Elements of OHSMS where the large scale public run enterprises engaged in the construction sector of India ***(Y axis)***.				
			Leadership & worker participation	Planning	Support	Operation	Performance evaluation
Scope for Improvement (2nd Priority) : Elements of OHSMS where the large scale private run enterprises engaged in the construction sector of India ***(X axis)***..	Leadership & worker participation	Count	66	7	1	1	0
		Expected Count	57.4	5.9	7.4	2.2	2.2
		% within (X axis)	88.0%	9.3%	1.3%	1.3%	0.0%
		Adjusted Residual	4.6	0.9	-4.8	-1.6	-2.9
		Calculated P value	0.00000	0.3508	0.00000	0.1092	0.0034
		Significance (comparing with Bonferroni correction factor)	Significant		Significant		
	Planning	Count	9	0	2	1	0
		Expected Count	9.2	0.9	1.2	0.4	0.4
		% within (X axis)	75.0%	0.0%	16.7%	8.3%	0.0%
		Adjusted Residual	-0.1	-1.1	0.9	1.2	-0.6
		Calculated P value	0.8983	0.2820	0.3947	0.2392	0.5209
		Significance (comparing with Bonferroni correction factor)					

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	Support	Count	3	1	6	0	1
		Expected Count	8.4	0.9	1.1	0.3	0.3
		% within (X axis)	27.3%	9.1%	54.5%	0.0%	9.1%
		Adjusted Residual	-4.1	0.2	5.3	-0.6	1.3
		Calculated P value	0.00005	0.8705	0.00000	0.5410	0.2012
		Significance (comparing with Bonferroni correction factor)	Significant		Significant		
	Operation	Count	0	0	1	1	1
		Expected Count	2.3	0.2	0.3	0.1	0.1
		% within (X axis)	0.0%	0.0%	33.3%	33.3%	33.3%
		Adjusted Residual	-3.2	-0.5	1.4	3.2	3.2
		Calculated P value	0.00153	0.6080	0.1642	0.0016	0.0016
		Significance (comparing with Bonferroni correction factor)	Significant			Significant	Significant
	Performance evaluation	Count	0	0	0	0	1
		Expected Count	0.8	0.1	0.1	0.0	0.0
		% within (X axis)	0.0%	0.0%	0.0%	0.0%	100.0%
		Adjusted Residual	-1.8	-0.3	-0.3	-0.2	5.8
		Calculated P value	0.0700	0.7694	0.7404	0.8611	0.00000
		Significance (comparing with Bonferroni correction factor)					Significant

Fig. 28. Cross tabulation with bonferroni correction factor (2nd priorities)

The significant degree of association/dependence of scope for improvement (2nd priority) between public run and private run enterprises were identified precisely between leadership/worker participation(public) & leadership/worker participation(private), support(public) & leadership/worker participation(private), leadership/worker participation(public) & support(private), support(public) & support(private), leadership/worker participation(public) & operation(private), operation(public) & operation(private), performance evaluation(public) & operation(private), and lastly, performance evaluation(public) & performance evaluation(private) (Fig 28).

N. Scope for improvement: 3rd priorities -

The frequency table (Fig 29) clearly indicates that the parent group variable of leadership & worker participation is the most frequent (66.7%) 1st priority for the scope for improvement in H&S performance of private run enterprises.

Now, the further break-up of top frequent parent group variable of leadership & worker participation indicates that nearly 27.9% was frequented by leadership & commitment, 19.1% frequented by OH&S policy, 47.1% by organizational roles & responsibilities and 5.9% by consultation & participation of workers.

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Variables for scope for improvement (3rd priority) in private run enterprises	3rd Priority (frequency)	Parent group Variables	3rd Priority (frequency)	Valid Percentage	Cumulative Percentage
Leadership & commitment	19	Leadership & Worker participation	68	66.7	66.7
OH&S Policy	13				
Organizational roles, responsibilities	32				
Consultation & participation of workers	4				
Hazard identification & risk management	4	Planning	11	10.8	77.5
Legal requirements	7				
OH&S objectives					
H&S resources	2	Support	5	4.9	82.4
Training & Competence	1				
H&S awareness	2				
Communication (internal & external)					
Documented information (creation, updation & control)					
Implementation of EHS/OHS procedures, manuals, control measures from RA in the field	4	Operation	13	12.7	95.1
OH&S Inspection regimes					
Management of change	1				
Contractor selection	5				
Emergency preparedness & response	3				
Monitoring and performance evaluation	1	Performance evaluation	3	2.9	98
Audits	2				
Continual improvement from OH&S violations, incidents, RCA, lessons learned etc.	2	Improvement	2	2	100
Total	102		102	100	

Fig. 29. Frequency table for 3rd priority (private)

The frequency table (Fig 30) clearly indicates that the parent group variable of leadership & worker participation is the most frequent (62.7%) 1st priority for the scope for improvement in H&S performance of public run enterprises.

Now, the further break-up of top frequent parent group variable of leadership & worker participation indicates that nearly 20.3% was frequented by leadership & commitment, 28.1% frequented by OH&S policy, 46.9% by organizational roles & responsibilities and 4.7% by consultation & participation of workers.

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Variables for scope for improvement (3rd priority) in public run enterprises	3rd Priority (frequency)	Parent group Variables	3rd Priority (frequency)	Valid Percentage	Cumulative Percentage
Leadership & commitment	13	Leadership & Worker participation	64	62.7	62.7
OH&S Policy	18				
Organizational roles, responsibilities	30				
Consultation & participation of workers	3				
Hazard identification & risk management	5	Planning	12	11.8	74.5
Legal requirements	3				
OH&S objectives	4				
H&S resources	3	Support	11	10.8	85.3
Training & Competence	4				
H&S awareness					
Communication (internal & external)	1				
Documented information (creation, updation & contro	3				
Implementation of EHS/OHS procedures, manuals, control measures from RA in the field	4	Operation	10	9.8	95.1
OH&S Inspection regimes	1				
Management of change	2				
Contractor selection	2				
Emergency preparedness & response	1				
Monitoring and performance evaluation	0	Performance evaluation	0	0	95.1
Audits	0				
Continual improvement from OH&S violations, incidents, RCA, lessons learned etc.	5	Improvement	5	4.9	100
Total	102		102	100	

Fig. 30. Frequency table for 3rd priority (public)

O. Relationship between the scope for improvement (3rd priority) for private and public run enterprises -

Null hypothesis(H0): There is no association between the scope for improvement for H&S performance between private and public run enterprises.

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Scope for Improvement (3rd Priority): Elements of OHSMS where the large scale private run enterprises engaged in the construction sector of India. * Scope for Improvement (3rd Priority): Elements of OHSMS where the large scale public run enterprises engaged in the construction sector of India. CROSSTABULATION								
			Scope for Improvement (3rd Priority) : Elements of OHSMS where the large scale public run enterprises engaged in the construction sector of India ***(Y axis).***					Total
			Leadership & worker participation	Planning	Support	Operation	Improvement	
Scope for Improvement (3rd Priority) : Elements of OHSMS where the large scale private run enterprises engaged in the construction sector of India ***(X axis).***	Leadership & worker participation	Count	57	4	3	3	1	68
		Expected Count	42.7	8	7.3	6.7	3.3	68
		% within (X axis)	83.80%	5.90%	4.40%	4.40%	1.50%	100.00%
	Planning	Count	3	4	2	2	0	11
		Expected Count	6.9	1.3	1.2	1.1	0.5	11
		% within (X axis)	27.30%	36.40%	18.20%	18.20%	0.00%	100.00%
	Support	Count	1	1	1	2	0	5
		Expected Count	3.1	0.6	0.5	0.5	0.2	5
		% within (X axis)	20.00%	20.00%	20.00%	40.00%	0.00%	100.00%
	Operation	Count	1	3	4	3	2	13
		Expected Count	8.2	1.5	1.4	1.3	0.6	13
		% within (X axis)	7.70%	23.10%	30.80%	23.10%	15.40%	100.00%
	Performance evaluation	Count	1	0	1	0	1	3
		Expected Count	1.9	0.4	0.3	0.3	0.1	3
		% within (X axis)	33.30%	0.00%	33.30%	0.00%	33.30%	100.00%
	Improvement	Count	1	0	0	0	1	2
		Expected Count	1.3	0.2	0.2	0.2	0.1	2
		% within (X axis)	50.00%	0.00%	0.00%	0.00%	50.00%	100.00%
Total		Count	64	12	11	10	5	102
		Expected Count	64	12	11	10	5	102
		% within (X axis)	62.70%	11.80%	10.80%	9.80%	4.90%	100.00%

Fig. 31. Cross tabulation for 3rd priorities

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Chi-Square Tests

	Value	df	Asymptotic Significance (2-sided)	Exact Sig. (2-sided)	Exact Sig. (1-sided)	Point Probability
Pearson Chi-Square	63.985[a]	20	<.001	.[b]		
Likelihood Ratio	56.093	20	<.001	<.001		
Fisher-Freeman-Halton Exact Test	59.880			<.001		
Linear-by-Linear Association	31.046[c]	1	<.001	<.001	<.001	.000
N of Valid Cases	102					

a. 24 cells (80.0%) have expected count less than 5. The minimum expected count is .10.

b. Cannot be computed because there is insufficient memory.

c. The standardized statistic is 5.572.

Fig. 32. Chi square tests for 3rd priorities

The requisite for running a successful chi square which demands the presence of minimum 5 values in all cells of the crosstab matrix was failed in the case, as 24 cells in the crosstabs had values less than 5. Hence, the Fisher-Freeman-Halton Exact test was executed to gather the significance value. The significance value for N=102 (Fig 31), reported was <0.001, which is less than 0.05 (Fig 32). Since reported P value was less than 0.05, the null hypothesis was rejected. Post hoc tests were run as a follow up analysis to delve deeper into the degree of association/dependence between the scope for improvement (3rd priority) for private and public run enterprises. The Bonferroni correction factor obtained was 0.00167 (0.05/30 i.e., Number of comparisons).

Scope for Improvement (3rd priority): Elements of OHSMS where the large scale private run enterprises engaged in the construction sector of India. * Scope for Improvement (3rd priority): Elements of OHSMS where the large scale public run enterprises engaged in the construction sector of India.

CROSSTABULATION

			Scope for Improvement (3rd priority) : Elements of OHSMS where the large scale public run enterprises engaged in the construction sector of India ***(Y axis).***				
			Leadership & worker participation	Planning	Support	Operation	Improvement
Scope for Improvement (3rd priority) : Elements of OHSMS where the large scale private run enterprises engaged in the construction sector of India ***(X axis).***	Leadership & worker participation	Count	57	4	3	3	1
		Expected Count	42.7	8.0	7.3	6.7	3.3
		% within (X axis)	83.8%	5.9%	4.4%	4.4%	1.5%
		Adjusted Residual	6.2	-2.6	-2.9	-2.6	-2.3
		Calculated P value	0.0000	0.0091	0.0033	0.0096	0.0232
		Significance (comparing with Bonferroni correction factor)	Significant				

	Planning	Count	3	4	2	2	0
		Expected Count	6.9	1.3	1.2	1.1	0.5
		% within (X axis)	27.3%	36.4%	18.2%	18.2%	0.0%
		Adjusted Residual	-2.6	2.7	0.8	1.0	-0.8
		Calculated P value	0.0100	0.0073	0.4024	0.3225	0.4253
		Significance (comparing with Bonferroni correction factor)					
	Support	Count	1	1	1	2	0
		Expected Count	3.1	0.6	0.5	0.5	0.2
		% within (X axis)	20.0%	20.0%	20.0%	40.0%	0.0%
		Adjusted Residual	-2.0	0.6	0.7	2.3	-0.5
		Calculated P value	0.0426	0.5578	0.4957	0.0199	0.6027
		Significance (comparing with Bonferroni correction factor)					
	Operation	Count	1	3	4	3	2
		Expected Count	8.2	1.5	1.4	1.3	0.6
		% within (X axis)	7.7%	23.1%	30.8%	23.1%	15.4%
		Adjusted Residual	-4.4	1.4	2.5	1.7	1.9
		Calculated P value	0.0000	0.1753	0.0129	0.0849	0.0609
		Significance (comparing with Bonferroni correction factor)	Significant				
	Performance evaluation	Count	1	0	1	0	1
		Expected Count	1.9	0.4	0.3	0.3	0.1
		% within (X axis)	33.3%	0.0%	33.3%	0.0%	33.3%
		Adjusted Residual	-1.1	-0.6	1.3	-0.6	2.3
		Calculated P value	0.2848	0.5209	0.2012	0.5622	0.0206
		Significance (comparing with Bonferroni correction factor)					

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	Improvement	Count	1	0	0	0	1
		Expected Count	1.3	0.2	0.2	0.2	0.1
		% within (X axis)	50.0%	0.0%	0.0%	0.0%	50.0%
		Adjusted Residual	-0.4	-0.5	-0.5	-0.5	3.0
		Calculated P value	0.7065	0.6020	0.6195	0.6377	0.0029
		Significance (comparing with Bonferroni correction factor)					

Fig. 33. Cross tabulation with bonferroni correction factor (3rd priorities)

The significant degree of association/dependence of scope for improvement (3rd priority) between public run and private run enterprises were identified precisely between leadership/ worker participation(public) & leadership/worker participation (private), and leadership/worker participation (public) & operation(private) (Fig 33).

V. CONCLUSIONS & RECOMMEDNATIONS

Conclusions -

The primary objective of this research was to conduct a comprehensive comparative analysis between the H&S performance of public and private run large scale enterprises engaged in the construction sector of India. After an extensive data collection and its entailing inferential data analysis which employed the non-parametric tests like binomial test and runs test, the research, herein concludes that the H&S performance of large scale private run enterprises are significantly greater than that of the public run enterprises engaged in the construction sector of India. This comparative analysis can be considered comprehensive as the comparison was carried out over 20 variables which were defined in ISO 45001:2018, as the elements of a H&S management system. It is also worthwhile highlighting the fact that none of the individual comparison carried out over the 20 variables had the public run enterprises performing better than private run. The results explicitly indicate that the public run enterprises engaged in the construction of India has to improve significantly in terms of its H&S performance, just to be on par with that of private run enterprises. However, the standard of H&S performance of private run enterprises engaged in the construction sector of India, in its own right was not discussed in the research as it was out of its scope.

The secondary objective of this research was to identify the scope for improvement for H&S performance on a priority basis in both public and private run large scale enterprises engaged in the construction of India and then to understand the degree of association/ relationship between the two. The research revealed that the 1st priority in the scope for improvement shall be given to leadership & commitment for both public and private run enterprises. The 2nd priority in the scope for improvement for H&S performance was reported by OH&S policy in both public and private run enterprises and 3rd priority was reported by organizational roles and responsibilities, again invariably in both public and private run enterprises. Now all these three variables belong to the parent variable of leadership and worker participation as defined by the ISO 45001:2018[55].

Now, all these 3 reported priorities are necessarily associated with the top management of an organization. OHS policy sets out a general approach to health and safety in a workplace [59]. It is a brief statement or a document that outlines how you, as an employer, will manage health & safety in their organization [59]. It shall also define who does what, when and how [59]. Again it is the responsibility of the leadership of the organization to develop and establish an OH&S policy. Needless to say that the organizational roles and responsibilities are always defined by the leadership of the organization and it is also their accountability to ensure that the defined organizational roles and responsibilities are complied with, with no deviation by all employees.

ISO clearly stated that the implementation of a H&S management system and improvement of H&S performance in a workplace depends entirely on the shared responsibilities of all employees all the way to the top and active role of top management of an organization as they are required to demonstrate their active involvement and ownership for the integration of H&S management system into their business processes [58]. ISO goes on to add that the implementation of ISO 45001 and the improvement of H&S performance relies heavily on the top-down approach, and that everything shall start from the leadership of the organization and that commitment shall be visible to all other employees [58]. The fact that leadership and commitment, OHS policy and organizational roles and responsibilities were predominantly chosen as the 1st, 2nd & 3rd priorities respectively for the scope for improvement in H&S performance, invariantly in both private and public run enterprises is quite alarming. This essentially indicates that the implementation of H&S

management system is merely superficial in the construction sector of India in both public and private run enterprises and that the leadership of these both kind of enterprises are not at all giving due importance and priority for the H&S performance in their workplace.

The inferential statistical tests carried out to analyze the degree of association/ dependence between the scope for improvement for private and public run enterprises explicitly revealed that the people who chose leadership & commitment as 1st priority for private run enterprises are very much likely to choose the same for the public run enterprises or vice versa. The chi square and the entailing post hoc tests further reveals that the people who chose OHS policy as 2nd priority for private run enterprises are very much likely to choose the same for the public run enterprises and this significance of dependence is similar for the 3rd priority, organizational roles and responsibilities as well.

This significant degree of association in all 3 priorities evidently indicates the heightened awareness of the H&S professionals engaged in the construction of India regarding the importance of leadership & commitment in improving the H&S performance in their workplace. The health & safety professionals all across the country, predominantly have the similar opinion regarding the poor involvement, engagement and commitment of the leadership of the enterprises (both private and public run) engaged in the construction sector of India over the affairs pertaining to health and safety. This sheer lack of leadership commitment and engagement can be thereby considered as one of the primary reason for the subpar performance of Indian construction sector with regards to occupational health and safety, when compared with the world standard [37]. This is also in line with the findings of Singh & Misra, 2021[16] and Saleem & Malik, 2022 [11] where they reached a conclusion that an effective involvement of leadership with a visible commitment, plays a rather prominent role in the health & safety performance improvement. The conclusion deducted herein is also aligned with the conclusions of Kineber et al., 2023[39], where they found commitment of the leadership over the implementation of H&S management system, formulating strategic objectives and policy & assigning clear roles & responsibilities to all levels of managements amongst the seven key elements influencing the implementation of H&S management system in an organization.

Recommendations -

The H&S performance of the large scale public run enterprises engaged in the construction sector needs to be improved substantially just to be on par with that of the private run enterprises. Since, public run enterprises were lagging behind private run in all the chosen variables that defines the H&S management system, public run enterprises need to come up with measures for mitigation in a war foot basis, as employee health and safety must be given the first priority in any workplace, let alone the construction sector. They could start by mobilizing competent ISO 45001 lead auditors in all of their workplace and conducting workplace audits on the basis of ISO 45001:2018. The comprehensive workplace audits shall reveal all the non-compliances in the workplace and the leadership of the public enterprises shall allocate all the resources needed to address the non-compliances identified. The active involvement and ownership by the leadership of public enterprises are cardinal in the effective implementation of the new measures of mitigation. However, this shall never be a one-time activity as proper plans shall be developed by the leadership for conducting periodic workplace auditing around the year. Third party auditing on ISO 45001 compliance by independent bodies would also be highly effective as third party entities wouldn't be having any innate leniencies to the organization they are auditing. This is in contrast with the in-house auditors, where they are likely to have some conflict of interests as they are essentially employees of the same organization. It is equally important to accurately document the findings of the audits and come up with action plans inclusive of target dates and the accountable employees. Follow up meetings shall be scheduled with accountable employees to review the deliverance on the action plan and finally a comprehensive continual improvement plan shall be developed and implemented for the organization as a whole.

The involvement and commitment of the leadership of both private and public run enterprises engaged in the construction sector of India needs to be substantially improved.

This can be achieved by incorporating better and more personal key performance indicators(KPI) pertaining to the H&S performance for all the employees that form part of the leadership. The KPIs must be an optimum amalgamation of leading and lagging indicators and must be chosen carefully by the H&S leader of the organization, depending on factors like the nature of business, number of people involved, inherent risk of the activities executed by the organization etc. It is of paramount importance that the assigned KPIs are approved by the CEO of the organization and are communicated with all the concerned people. The performance of the KPI shall be periodically reviewed along with its evidences and corrective actions must be devised where shortcomings are identified. A reward and reprimand program could also be developed in order to increase the motivation of people. Further, as part of the continual improvement, the KPI targets must be reviewed and updated in an annual basis as well. All of these measures can collectively improve the involvement and commitment of the leadership of the organizations over the affairs pertaining to the workplace health and safety.

Limitations & scope for further study -

As the study just compares the H&S performance between the private and public run large scale enterprises, the H&S performance of each kind of enterprise in its own right was not fully discussed. Hence, the study is not able to tell us whether the private run enterprises are operating in full compliance with the ISO 45001:2018 or not. A further detailed study can be

conducted to comprehend the H&S performance of private run large scale enterprises engaged in the construction sector of India.

This study has not analyzed the root causes for poor H&S performance of the public run large scale enterprises engaged in the construction sector of India, although top 3 areas for improvement were collected, analyzed and discussed. A comprehensive investigation is necessary to further examine the root causes for the poor H&S performance of the public run enterprises.

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