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BOARD OF ENGINEERS MALAYSIA

THE INGENIEUR

VOL.96
OCTOBER-DECEMBER 2023

MAGAZINE OF THE BOARD OF ENGINEERS MALAYSIA

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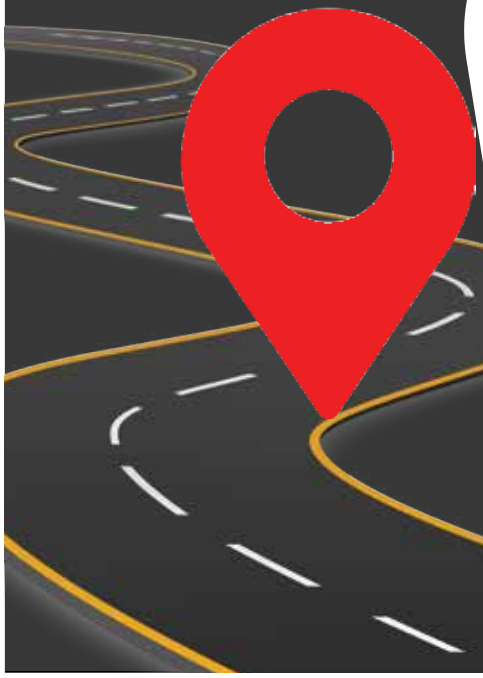
Registration of Road Safety Auditor (RSA)



Pursuant to the Board's decision on 6th June 2023, the registration of Road Safety Auditor (RSA) will be placed under the purview of BEM with effect from 1st August 2023. All existing RSA registered with Jabatan Kerja Raya (JKR) prior to this date will be offered to be transferred to BEM's Register as their saving rights. This saving rights will expire by 31st December 2023.

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2023-2024

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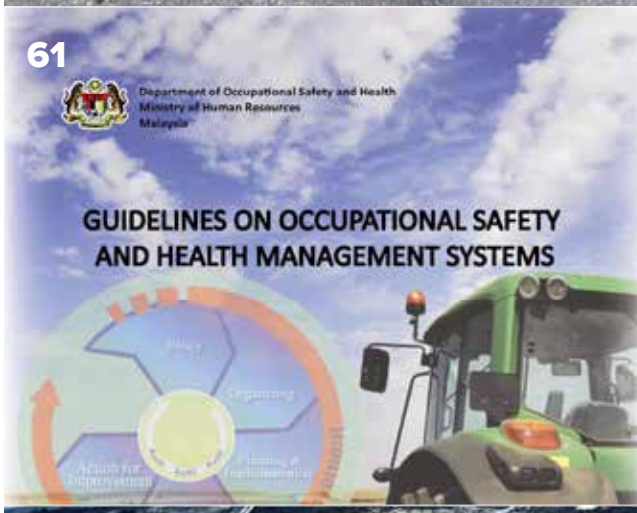

Health, Safety and Environment

The Department of Occupational Safety and Health (DOSH) revealed during the recent Annual General Meeting and Conference Asia Pacific Occupational Safety & Health Organisation (APOSHO) 2023 that there were 2.22 workers per 1,000 involved in occupational injuries and 2.06 workers per 100,000 involved in fatal occupational accidents in Malaysia.

Health, Safety and Environment (HSE) are critical aspects of engineering and industrial operations. Engineers play a crucial role in ensuring the well-being of people, protecting the environment and complying with regulations. In this regard, engineers are expected to design and implement processes and systems that minimise environmental impact and promote long-term sustainability.

Globally, there is a growing push for harmonised international HSE standards. Organisations like the International Labour Organisation (ILO), the World Health Organisation (WHO), and the United Nations Environment Programme (UNEP) play vital roles in setting global expectations. The International Labour Conference in June 2022, in its Declaration on Fundamental Principles and Rights at Work, called to include 'a safe and healthy environment' as the key principle to achieve its objective.

The need to assess and evaluate contractor performance at the work site in respect to safety and health is well explained in the article on 'Safety and Health Assessment System in Construction (SHASSIC)' which listed five objectives for its enhancement. SHASSIC looks at benchmarking, standard system of assessment, corrective action and data gathering for statistical analysis.

The oil and gas industry is reputed to have the highest standards in safety and health in its operations. The concept of Human Factor Engineering (HFE) is an important way to address the potential hazards resulting from human errors by integrating this concept into the early stage of facility design. The article on 'Current Human Factor Engineering Practices in the Oil and Gas Sector' illustrates how it will enhance the operability, maintainability and user acceptance of the facilities and equipment.

Hazard identification in oil and gas plants is equally important and gaining greater emphasis in recent times. Numerous countries have implemented regulations mandating the utilisation of formal hazard identification techniques. The article on 'The Crucial Role of HAZOP in the Oil & Gas Industry' provides detailed insight into the method of hazard and operability (HAZOP) assessment as a systematic and meticulous assessment approach for facilities, processes and operations.

With the recent amendment to the Occupational Safety and Health Act (Amendment 2022) and the introduction of Occupational Safety and Health in Construction Industry (Management) OSHCIM, there will be a paradigm shift in the control of work site safety and health. I urge the engineering fraternity to pay special attention to these important new policies that are meant to improve work site safety, provided all stakeholders adhere to their principles and direction.

Safety Begins with You.

Datuk Ir. Ahmad Redza bin Ghulam Rasool
President, BEM

CALL FOR ARTICLES

The Ingenieur is published quarterly by the Board of Engineers Malaysia. The following are the themes for the coming issues.

- Vol. 97 January-March 2024
  Environmental Social Governance (ESG)
- Vol. 98 April-June 2024
  Engineering & Law
- Vol. 99 July-Sept 2024
  Agriculture Engineering

Articles and other contributions relevant to the themes are welcomed, but the decision to publish rests with the Editorial Board.

Advertising inquiries are also welcomed. Please refer to the BEM advertisement on Page 41 for the latest rate card and booking form.

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Virtual Environmental Imaging Technology Enhances Maintenance of Biomedical Assets

By **Ir. Dr Muhammad Syukri Imran Abdullah,**
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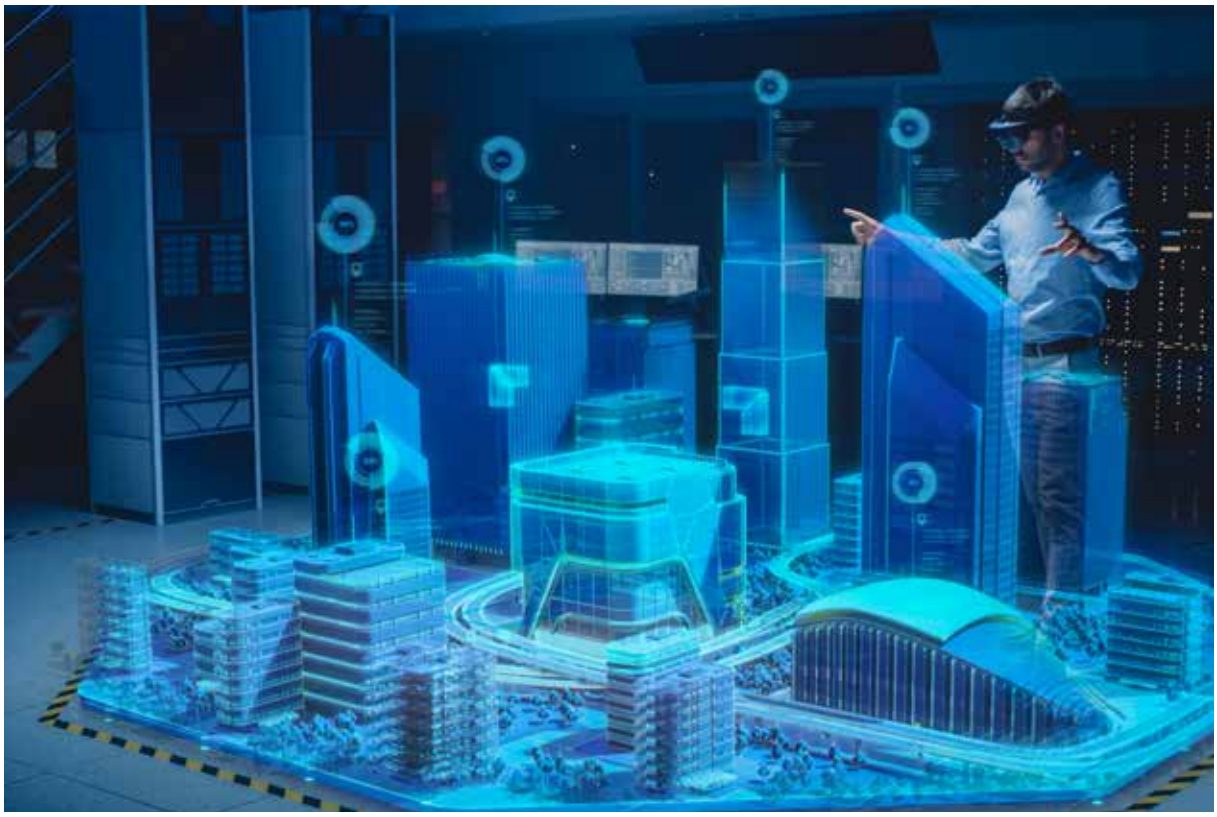
Ir. Ts Siti Aisyah Bt Sapiee,
Engineering Division, Sarawak State Health Department

Dzatul Ithri Amran,
Engineering Services Division MOH, Secretary Biomedical Engineering Association of Malaysia

Government hospitals provide a wide range services and house many facilities including biomedical equipment to ensure 24-hour healthcare services. The hospital's facility managers need to leverage current resources to ensure minimum interruption to all critical functions which heavily rely on various type of biomedical equipment (BE). There are opportunities to integrate the use of emerging technologies such as 3D virtual environment imaging in facility management services of hospitals. The visualisation capability provided by such technology could greatly improve BE maintenance management process such as BE inventory upkeep, BE operation and routine maintenance processes, BE replacement and upgrades and BE safety and health. It also helps in the disaster management process as seen in increased mobility of BE across the Ministry of Health (MOH) facilities during the recent COVID 19 pandemic. The feasibility and acceptability of such technology in BE management should be further explored to optimise disaster response as well as out-of-hospital management of BE. MOH have taken a keen interest in such technology and is moving forward to test and implement such tools in this era of distance learning and distance managing.

Increasing Trend of 360 Image Virtual Environment

Panoramic virtual reality can create highly realistic and detailed representations of the real environment while giving users a sense of immersion (*Pereira et al., 2017*). 360 cameras have huge potential across domains such as retail, construction, tourism and even cultural heritage due to its versatility enabling users to capture the world with an omni-directional view with just one shot (*Fangi et al., 2018*). Advances in computer technology led to 3D modelling and visualisation that is now commonly being used in



360 images can create digital twin of real-life space

urban planning as well as property development related activities. Real estate and developers have turned to immersive technologies to give buyers a more interactive online experience to access and view the built property or unbuilt property development. The virtual tour of built property is made up of 360 images of the location created by 360 compatible camera or imaging devices.

There are many cloud-based software or programmes that can process the 360 images to create a digital twin of the real-life space and creating a 3D virtual tour. The 3D virtual tour allows viewers to have a 360-degree perspective of the property at any point in the house and even take accurate measurement form the virtual model. Property agents could also add information in the virtual tour through digital labelling that provides narration, images, videos and even document that can be downloaded. Research by *Afrooz et al., (2018)* have shown that 3D digital modelling has been well received as a toolkit for urban planning process making the development application process (DA) in Sydney Australia faster and efficient. The DA process involves documentation checking such as forms, 2D site plans, consultant reports but lack 3D data visualisation that makes it difficult for most people to envision the approved building presented originally in 2D. Therefore, there has been keen interest in using 3D models not only in the DA process but also for community engagement, streetscape, and urban design as well as interior design exploration.

Teicholz, (2012) has explained in his book about technologies like 3D modelling and simulation tools for facility management processes that can save time and money as well as assists facility managers to identify optimal or near optimal solutions. Use of such business intelligence (BI) facilitates managers in better budgeting and optimal allocation of resources in repair, renewal, and modernisation of ageing facilities. Building visualisation using 3D digital model as well as building information modelling (BIM) shows great promise and is increasingly endorsed by facility managers as they need more efficient ways to

collect and access information for maintenance and operation of most facilities (*P. Teicholz, 2013*). However, research have shown that 360 Image-based Immersive Virtual Environment (IVE) could potentially improve human experiences and performance compared to traditional IVEs although they provide less interactivity (*Amezquita Radillo, 2022)*

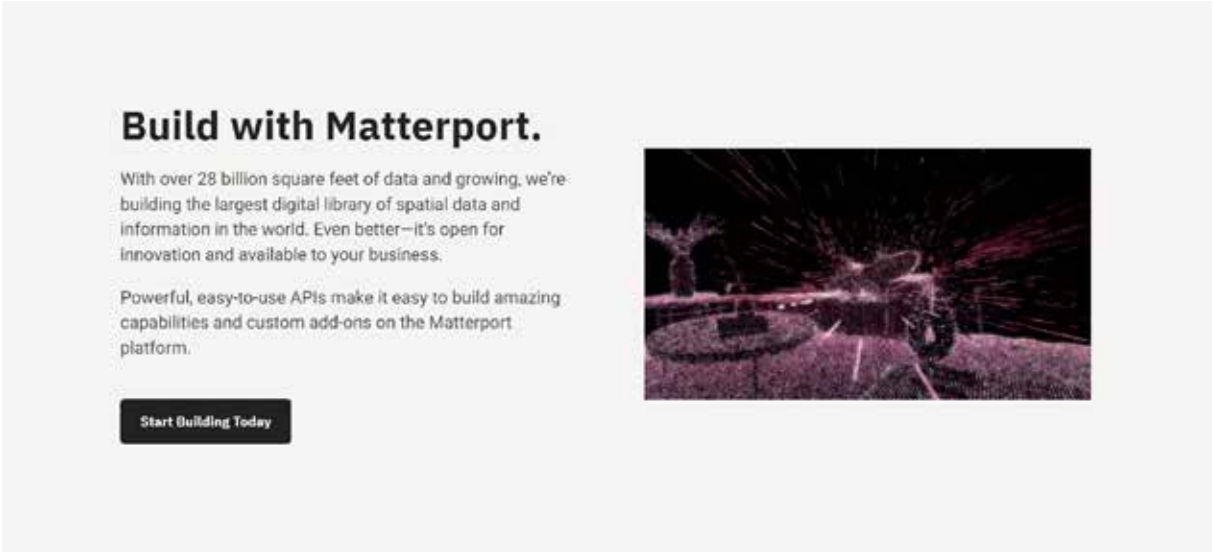
Visualisation is an important tool in the process of education and training, not only in the classroom but also for open learning via the web (*Haque et al., 2005).* The same tool has become an important part of facility management that requires training for new or visiting employees so that they can quickly navigate the facility and get work done. The 3D walkthrough training tool also contributes to increase in situational awareness for staff and even serve as a guidance to better respond in case of emergency or disasters incidents. The same approach was used by University of Western Australia that has developed a 360 virtual laboratory tour to help its first-year students to familiarise and prepare for an upcoming laboratory class (*Clemons et al., 2019*).

Lovelace, (2019) has shown in his survey that the Department of Transportation Minnesota have been using image equipment such as 360 camera and light detection and ranging (LiDAR) to create and utilise 3D modelling to document its existing facilities, communicate inventory and inspection data. Scanning technology such as Ni drones, LiDARs, cameras and lasers as well as processing software can be used to digitally document building sites, exteriors and building interiors to effectively manage these important assets. 360 cameras have also been used with drones to carry out bridge inspection making the inspection process more cost effective and safe (*Humpe, 2020*). Similar methods have also been made in conservation, assessment and management of historic buildings. 3D reality based on 360 scenes is being used as a versatile tool for smart documentation of historic building and allowing remote access for users, technicians and authorities to evaluate conservation and safety measures for the historic buildings (*De Fino et al., 2022).* Very recently, *Chow et al., (2021)* have introduced a work method for automated defect inspection on concrete structure which utilise 360 camera and LiDAR. The image and LiDAR data allow mapping and integration of the structure defects into a BIM model to better manage facility. Digital transformation has been driving more effective practices in variety of domains including asset management. A broad spectrum of advanced technology and solutions are available which include drones, 3D interface, 360 images laser scanning, web services and mobile apps that should be assessed at system level due to its multi-dimensional benefits. (*Kortelainen et al., 2020*)

Challenges in Biomedical Asset Management in MOH Facilities

The outbreak of COVID-19 has increased demand for hospitals' specific treatment facilities. During the pandemic, the surge of COVID 19 patients led to over stressing of certain BE assets as well as increased demand for ventilators. The current asset information system, ASIS, which contains the inventory of BE across hospitals has limitations especially in out-of-hospital interventions and managing of critical BE asset at hospital level. The module in ASIS computerised information system currently contains records such as asset register, user area and user location for every MOH hospital. The system only records and stores text-based data without any form of visualisation format therefore making it difficult for the information system user who is unfamiliar with BE to verify and visualise the BE itself including its location. Location and asset ID are required following any breakdown complaint by both equipment users and maintenance personnel, which could be time and cost-consuming even before any corrective action can be taken. Therefore, visualisation technology such as the 360 image-based virtual environment application allow more efficient facility management processes resulting in quick respond time and timely corrective action. Usage of such tool not only allows effective BE maintenance and uptime, but also improve optimisation of emergency planning and response in critical events such as the COVID 19 pandemic.

Timely location verification of BE asset is also essential to avoid theft and misplacement, especially in the ward department, where sometimes BE assets are found in unintended



locations or not found at all. This situation could be life threatening if critical BE is not found and sent to where it is needed urgently. The current practice of physical verifications seems to be lacking due to complacency and issues related to human factors.

Sarawak General Hospital Pilot Study- Feasibility and Acceptability

A feasibility study was carried out in Pathology Department, Sarawak General Hospital to demonstrate the feasibility of 360 image based virtual environment model and acceptability by stakeholders and relevant key persons. A 360-image based 3D digital model as shown in Figure 1 was created using Matterport technology representing indoor layout and include other useful content such as digital asset tagging, and other information deemed critical for BE asset managers.

The 3D model allows for visual biomedical inventory that can be easily identified in the virtual environment. At present the captured 3D image is accessible from a third-party cloud based software for a subscription fee. A professional 360 image scanning device was used to create the 3D virtual environment which was easily operated by a single person to scan the building, room to room and floor to floor until all the building floor plans

Figure 1: Cytopathology Department Dollhouse View using Matterport technology.

Figure 3: Print screen of a Virtual Environment of a lab room

Figure 4: Examples of asset tagging and descriptions (biomedical assets)

Figure 5: Asset inventory list in virtual tour format with search box

were covered. A third-party cloud-based software accessible through subscription was used to convert the image into an interactive Virtual Environment (VE) model. A sample VE screen shot is shown in Figure 3. The software artificial intelligent capability can identify objects in the rooms, stitch all the room scans together and reconstruct the space into an immersive virtual tour while allowing users to add more content such as digital tags with texts, links and videos.

The tagging feature in Matterport enhances virtual tours functionality with customisation options, making them more informative and engaging for users. Users can easily access the tagging feature in Matterport by clicking on the tag icon on the virtual tour screen. The tags can include descriptions and relevant information about the object or area, such as the type of asset, the registration number of the asset, its model, and its serial number as shown in Figure 4. The tagging feature is a useful tool for BE asset management as it allows for easy identification and tracking of assets as well as maintenance needs. Search box is also provided in the VE interface to allow users to search for a particular asset or location quickly as shown in Figure 5.

Apart from that, a questionnaire link was distributed to stake holders and facility management team to get their feedback on application of 3D virtual environment technology in BE asset management. Based on the survey results shown in Figures 6 (a) and (b), the majority of respondents found that the 360 image-based virtual tour usage in BE management to be useful and valuable. Most respondents agree that the technology provides multiple benefits in improving facility management which includes BE assets. The high level of user acceptance suggests that the application meets or exceeds user expectations and provides meaningful benefits for BE management. The majority of respondents agree that VE could greatly enhance maintenance and repairs of BE assets as well as allow the training of a maintenance or repair team in a virtual environment.

Conclusion

The development of a 3D virtual environment model for BE maintenance aims to improve operation and management of hospitals while providing economic and effective options for onsite or off-site facility managers, engineers, medical planners, or asset management team. Pilot VE model of the Sarawak General Hospital Cytopathology unit provides valuable insight into the feasibility and acceptability of such technology. 3D virtual environment imaging technology such as Matterport has the potential to revolutionise BE maintenance by providing accurate and up-to-date information on assets, enabling more efficient and effective resource allocation. Feedback from stakeholders such as administrators, engineering facility managers, engineering team, medical planners or asset management team have shown a high acceptance rate. Survey results also demonstrated that most users are

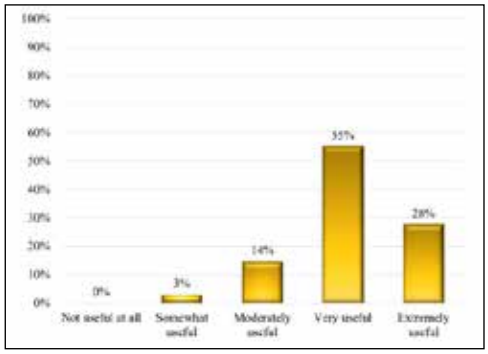


Figure 6 (a): Feedback on the level of usefulness of 360 image-based VE Application

Figure 6 (b): Maintenance team feedback on the benefit of VE Application in BE operation maintenance

highly contented with the benefits provided by virtual tours technology, including improved asset management, verification, streamlined inspections, enhanced communication, better decision making, and improved safety. ■

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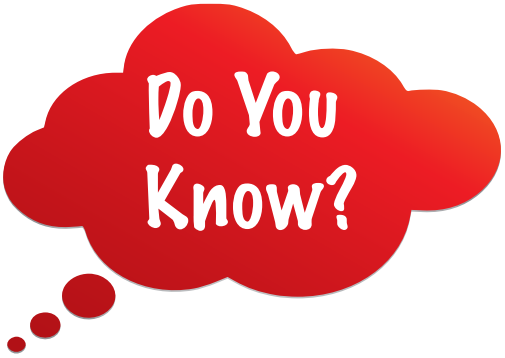

Health, Safety and Environment

By Pang Soo Mooi

World Day for Safety and Health at Work

The world celebrates the *World Day for Safety and Health at Work* every April 28. This day is dedicated to promoting safe, healthy, and decent work environments and raising awareness about the importance of occupational safety and health (OSH). Engineers play a crucial role in ensuring workplace safety and have various responsibilities in this regard.

Malaysia, being a member of this international community, regards it as an integral part of the national strategy for promoting a preventative safety and health culture involving all stakeholders. It is an awareness-raising campaign to focus international attention on emerging trends in the field of occupational safety and health and the magnitude of work-related injuries, diseases and fatalities worldwide.

In this regard, innovation and innovative practices play a crucial role in improving the OSH landscape and shaping Occupational Safety and Health Management Systems (OSHMS) for the future.

Establishing a safe and healthy work environment requires fundamental changes in the culture of the organisation, in the way work is designed, how personnel are deployed, and how the organisation understands and acts on safety.

The implementation of the *Occupational Safety and Health Master Plan 2021-2025* (OSHMP25), which outlines the seven strategic core values, is another milestone in improving safety at Malaysian work sites.

The Enormous Burden of Poor Working Conditions – *International Labour Organisation*

The International Labour Organisation (ILO) estimates that some 2.3 million women and men around the world succumb to work-related accidents or diseases every year; this corresponds to over 6,000 deaths every single day. Worldwide, there are around 340 million occupational accidents and 160 million victims of work-related illnesses annually. The ILO updates these estimates at intervals, and the updates indicate an increase in accidents and ill health.

The estimated number of fatal occupational accidents in the Commonwealth of Independent States countries is over 11,000 cases, compared to the 5,850 reported cases (information lacking from two countries). The gross under-reporting of occupational accidents and diseases, including fatal accidents, is giving a false picture of the scope of the problem.

Some of the major findings in the ILO's latest statistical data on occupational accidents and diseases, and work-related deaths at a worldwide level, include the following:

- Diseases related to work cause the most deaths among workers. Hazardous substances alone are estimated to cause 651,279 deaths a year.
- The construction industry has a disproportionately high rate of recorded accidents.
- Younger and older workers are particularly vulnerable. The ageing population in developed countries means that an increasing number of older persons are working and need special consideration.

Engineers required strict safety regulations during the Golden Gate Bridge construction - *Blr.com*

In the 1930s, when the construction of San Francisco's Golden Gate Bridge was underway, it was commonplace for the industry to accept one fatality for every million dollars invested in a project. However, Chief Project Engineer Joseph Strauss refused to accept this status quo. Determined to prioritise safety, he commissioned a rope-and-mesh safety net beneath the bridge's roadway structure. This innovative net proved crucial in saving the lives of 19 workers, who became known as members of the "Halfway-to-Hell Club," as documented by the Golden Gate Highway & Transportation District. Additionally, Strauss enforced strict safety measures, including the mandatory use of hard hats, safety lines, and respirators during riveting to prevent workers from inhaling lead-contaminated fumes. Failure to comply with these practices resulted in potential dismissal. Despite these precautions, 11 lifes were lost during the project, with 10 deaths occurring after a scaffold section fell through the safety net. However, it is important to note that without the net and other stringent safety requirements, the number of fatalities would have been significantly higher.

This historical example highlights the crucial starting point of any successful safety programme: acknowledging that the existing standards are insufficient to adequately protect workers. It involves thoroughly documenting safety concerns, collaborating with regulatory bodies to establish appropriate standards, and educating employees to ensure they possess the knowledge and understanding needed to keep themselves safe.

Top Ten Health and Safety Risks in Construction - *Safeworkplace*

The construction industry accident fatality rate stands at more than double that of the all-sector average – minor accidents are almost incalculably more. Put simply, construction sites are a health and safety nightmare – almost every conceivable hazard exists within this constantly changing working environment.

However, the hazards associated with construction sites are well known. Most responsible employers are aware of their duty of care to employees, visitors, and those that may be affected by their activities, and will manage the site effectively, implementing appropriate accident prevention measures. Risk assessments are carried out by management to identify hazards and the risks posed.

Listed below are the main hazards that are encountered on a typical construction site:

1. Working at Height

The construction of buildings – or indeed, demolition works – frequently requires tradesmen to work at height. Fatalities and injuries involving height-related factors account for many accidents each year.

The risks associated with working at a height are often increased by added access and mobility restrictions. Training, including safety awareness training, is essential for employees required to work at height.

2. Moving Objects

The work site is an ever-changing environment; hazards are inherent to this industry and they only increase as the construction project progresses, as things rise and expand.

Construction sites can get quite hectic with the sheer volume of constantly moving vehicles and tradespeople, overhead lifting equipment shifting heavy loads, supply vehicles and dumper trucks everywhere, all manoeuvring around a usually uneven terrain.

3. Slips, Trips, & Falls

When you consider the diverse range of activities going on at a construction site at any one time, it seems hardly surprising that slips, trips, and falls happen on an almost daily basis.

Construction sites are a mash of holes in the ground, buildings at various stages of completion, scaffolding, stored materials and equipment — you really need eyes in the back of your head at times.

4. Noise

Noise is a major hazard within the construction industry. Repetitive, excessive noise causes long-

term hearing problems and can be a dangerous distraction, a common cause of accidents.

Beware that using simple earplugs does not necessarily offer total protection against hearing damage – employers are required to carry out and document a comprehensive noise risk assessment and issue appropriate PPE.

5. Hand-Arm Vibration Syndrome

Hand-arm vibration syndrome, or 'blue finger' as it is commonly referred to, is a painful and debilitating industrial disease of the blood vessels, nerves and joints, triggered by the prolonged use of vibratory power tools and ground working equipment.

This industrial disease is frequently cited in compensation claim cases opened by ex-construction workers who worked for years with little or no protection, using inappropriate and poorly maintained equipment.

6. Material & Manual Handling

Materials and equipment are being constantly lifted and moved around on a construction site, whether manually or with the use of lifting equipment. Different trades will involve greater demands, but all may involve some degree of risk.

Where the employee's duties involve manual handling, adequate training must be carried out. Where lifting equipment is used, adequate training must also be carried out but may involve some form of test, to confirm competency. Records of training must be maintained for verification.

7. Collapse

Not exactly a hazard, more a risk – an accident in waiting.

Every year, excavations and trenches collapse, burying and seriously injuring people working in them. Precautions need to be planned before the work starts.

The risk of an unintended collapse is generally more associated with demolition works or partially completed buildings and collapsing scaffolding but they still account for a percentage of fatalities each year.

8. Asbestos

Today there is a new generation of construction workers — joiners, electricians and plumbers — for whom asbestos is seen as a historical problem, something from the past that's now long gone, but that is a mistake.

9. Airborne Fibres & Materials – Respiratory Diseases

Construction sites are a hive of activity and kick up a lot of dust which often is an invisible, fine, toxic mixture of hazardous materials and fibres that can damage the lungs, leading to diseases such as chronic obstructive pulmonary diseases, asthma and silicosis.

10. Electricity

On average, three construction industry workers are electrocuted each year during refurbishment work on commercial and domestic buildings. People working near overhead power lines and cables are also at risk. There is also a growing number of electrocutions involving workers who are not qualified electricians but who are carrying out electrical work, such as plumbers, joiners and decorators.

Indoor Air Quality - *US Department of Labour*

The quality of air inside offices, schools, and other workplaces is important, not only for workers' comfort but also for their health. Poor indoor air quality (IAQ) has been tied to symptoms like headaches, fatigue, trouble concentrating, and irritation of the eyes, nose, throat and lungs. Also, some diseases, like asthma, have been linked to specific air contaminants and damp indoor environments. In addition, some exposures, such as to asbestos and radon, do not cause immediate symptoms but can lead to cancer after many years.

Many factors affect IAQ. These factors include poor ventilation (lack of outside air), problems controlling temperature, high or low humidity, recent remodelling, and other activities in or near a building that can affect the fresh air coming into the building. Sometimes, specific contaminants like dust from construction or renovation, mould, cleaning supplies, pesticides, or other airborne chemicals (including small amounts of chemicals released as a gas over time) may cause poor IAQ.

The right ventilation and building care can prevent and fix IAQ problems. Although the Occupational Safety and Health Administration (OSHA) does not have IAQ standards, it does have standards about ventilation and standards on some of the air contaminants that can be involved in IAQ problems. OSHA responds to questions about standards with letters of interpretation. OSHA's letters of interpretation specifically addressing IAQ issues can be found in *Other Resources. The General Duty Clause of the OSH Act* (the law that created OSHA) requires employers to provide workers with a safe workplace that does not have any known hazards that cause or are likely to cause death or serious injury.

Joint ILO/WHO Committee on Occupational Health – *International Labour Organisation*

The main focus in occupational health is on three different objectives:

(i) the maintenance and promotion of workers' health and working capacity;

(ii) the improvement of the working environment and work to become conducive to safety and health; and

(iii) the development of work organisations and working cultures in a direction which supports health and safety at work and in doing so also promotes a positive social climate and smooth operation and may enhance the productivity of the undertakings.

The concept of working culture is intended in this context to mean a reflection of the essential value systems adopted by the undertaking concerned. Such a culture is reflected in practice in the managerial systems, personnel policy, principles for participation, training policies and quality management of the undertaking.

Those in the field of occupational health come from a wide range of disciplines and professions, including medicine, psychology, epidemiology, physiotherapy and rehabilitation, occupational medicine, human factors and ergonomics, and many others. Professionals advise on a broad range of occupational health matters. These include how to avoid particular pre-existing conditions causing a problem in the occupation, correct posture for the work, frequency of rest breaks, preventive action that can be undertaken, and so forth.

The quality of occupational safety is characterised by:-

1. the indicators reflecting the level of industrial injuries;
2. the average number of days of incapacity for work per employer;
3. employees' satisfaction with their work conditions; and
4. employees' motivation to work safely.

Occupational health should aim at:

- the promotion and maintenance of the highest degree of physical, mental and social well-being of workers in all occupations;
- the prevention amongst workers of departures from health caused by their working conditions;
- the protection of workers in their employment from risks resulting from factors adverse to health;
- the placing and maintenance of the worker in an occupational environment adapted to his physiological and psychological capabilities; and
- the adaptation of work to man and of each man to his job.

Given the high demand in society for health and safety provisions at work based on reliable information, occupational safety and health professionals should find their roots in evidence-based practice. A new term is "evidence-informed decision-making". A working definition of evidence-based practice could be "evidence-based practice is the use of evidence from literature and other evidence-based sources, for advice and decisions that favour the health, safety, well-being, and work ability of workers". Evidence-based information must be integrated with professional expertise and the workers' values. Contextual factors related to legislation, culture, financial, and technical possibilities must be considered. Ethical considerations should be heeded. ■

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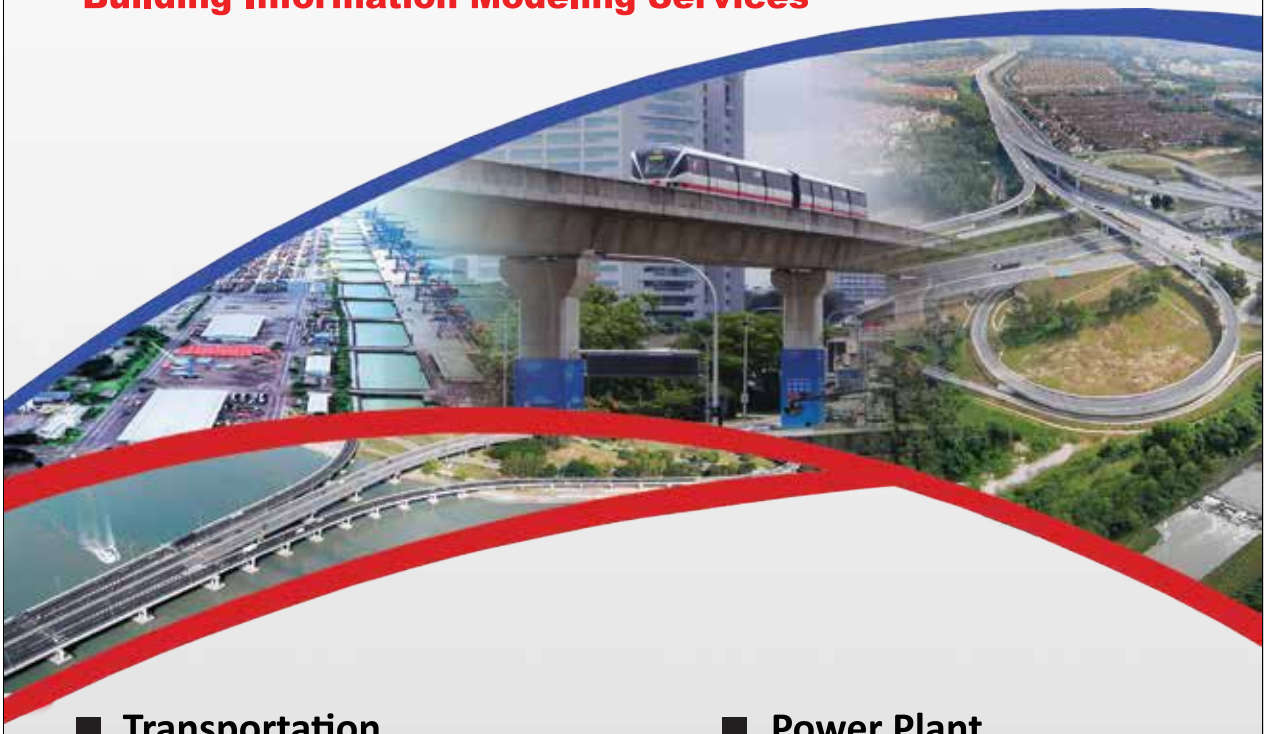

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