BSC. (HONS) COMPUTER SCIENCE AND SOFTWARE ENGINEERING

UNIVERSITY OF BEDFORDSHIRE

Smart Web Application for Institute of Occupational Safety and Health, Sri Lanka

Contextual Report

Student Registration Number	**2523630**
Student Name	**M.G.T. Bandara**
Supervisor's Name	**Mr. Alfred Edwin**
Module Name	**Research Methodology and Emerging Technologies.**

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1. Introduction

Occupational safety and health (OSH) are essential for protecting employees and supporting productivity in industries. Today, OSH is recognized as an important part of industrial management because workplaces must protect workers from hazards while maintaining efficiency. Modern views on OSH focus on preventing risks early, understanding worker behaviour, and creating healthy working environments, rather than only following legal requirements. This approach shows that good OSH practices lead to fewer injuries, better employee participation, higher morale, and overall socio-economic benefits.

In developing countries like Sri Lanka, the role of OSH has become more important due to industrial growth, larger workforces, and different types of workplace risks. However, many industries still do not have proper monitoring systems, hazard assessments, or standard safety procedures. As a result, injuries and accidents are reported in several industries, most of them are preventable. Institutions that work in the field of OSH play a key national role by raising awareness, guiding compliance, conducting safety assessments, and providing professional support.

The Institute of Occupational Safety and Health (IOSH) Sri Lanka is one such institution. It offers services such as environmental testing, medical examinations, workplace audits, certification, and safety training. Although these services are important, many of IOSH's administrative tasks are still done manually using paper files, spreadsheets, and separate documents. This creates problems such as scattered information, delays in processing, difficulty retrieving past records, poor communication, and a higher chance of errors.

With the growth of digital technologies, industries are increasingly expecting to use modern digitalized systems that improve data management and efficient overall management of the service provided by them. Web-based platforms can store information in one place, automate routine tasks, improve communication, and ensure secure data handling. Adding artificial intelligence (AI) can further support predictive alerts, automated reminders, structured reporting, and data-driven decision-making. These tools help industries to move from reactive safety management to proactive and continuous improvement.

In this context, the present study aims to design and develop an AI-enabled smart web application for IOSH Sri Lanka. The system is intended to improve administrative efficiency, increase accuracy, reduce manual workload, and provide a centralized digital platform for member data, certificates, assessments, communication, and reporting. This research examines the limitations of current

processes, identifies system requirements, and evaluates how the new system can improve OSH service delivery in Sri Lanka.

1.1 Background

Workplace safety is becoming more important as industries try to balance productivity with the need to protect employees. International OSH frameworks encourage proper hazard identification, risk assessment, and prevention methods to reduce workplace injuries and illnesses. Developing countries often face challenges such as weak enforcement of safety regulations, limited access to trained safety professionals, and a lack of resources. With the growth of commercial, industrial, manufacturing, and healthcare sectors in Sri Lanka, the need for strong OSH systems is increasing. Occupational safety practices are now focused on prevention, need to be align with the global standards and adjust to the new challenges of the digital era (International Labour Organization, 2023).

IOSH Sri Lanka plays an important role in improving workplace safety of the industries by providing services to follow safety standards and protect employee wellbeing. These services include environmental testing in laboratories, medical examinations for workers and provision of medical certificates and safety training programs. However, the organization still relies on manual data handling, which leads to several problems. These include difficulty keeping accurate records, slow access to information, no centralized system to track data, limited ability to analyze safety patterns, and overall inefficiencies in service delivery.

New digital technologies can help to solve these issues by offering centralized databases and automated processes to improve the accuracy in data handling and communication systems among industries and other stakeholders. AI can further support these improvements by providing stronger analytics, predicting risks, sending automated reminders, and organizing information more efficiently. These advancements support the idea of creating a modern digital platform for IOSH Sri Lanka.

1.1.1 Inspiration

The motivation for this study comes from the limitations in IOSH's current manual workflows and the need to adopt modern digital and AI-supported systems for safety management. Although many international organizations use digital and AI-based OSH tools, such systems are still not widely used in Sri Lanka. Introducing a digital platform would reduce administrative work, prevent record-keeping errors, improve communication with stakeholders, and make the processing of certifications and assessments faster and more efficient.

This project aims to replace outdated manual documentation, make it easier to access past records, provide automatic reminders for certificate expiries, support decision-making through forecasting tools, improve transparency and accountability, and offer real-time access to important information.

Developing a smart web application gives IOSH the opportunity to modernize its operations and align its safety practices with new technological standards.

1.1.2 Justification of the need of developing a modern digital solution for IOSH

Several issues within IOSH highlight the need for a modern digital solution. The current record-keeping system is fragmented, liable to manual entry errors, and makes it difficult to find past information. Operational processes are slow, with delays in issuing certificates, heavy manual workloads, and unclear communication channels. There is also no centralized digital system and the staff do not have real-time access to information and many workflows cannot be automated. In addition, IOSH lacks tools for analyzing trends, forecasting risks, or generating meaningful safety insights. These challenges highlight the importance of developing and adopting a modern digital platform to improve efficiency and accuracy.

1.2 Project Aims and Objectives

1.2.1 Project aims

The aim of this study is to design and implement an AI-supported smart web application that digitalizes IOSH operations, enhances service efficiency, improves data accuracy, and supports proactive occupational safety management in Sri Lanka.

1.2.2 Objectives

1. To evaluate the existing manual data monitoring system of the Institute of Occupational Safety and Health.
2. To develop a more user-friendly platform for the Institute of Occupational Safety and Health to manage environmental and medical certificates and administrative processes smoothly.
3. To accommodate prospective forecasting, reminders, and safety features to support decision-making of the Institute of Occupational Safety and Health.
4. To apply a secure database with training, certification, communication, and member modules for the Institute of Occupational Safety and Health.

5. To evaluate the effectiveness and usability of the new system developed for the Institute of Occupational Safety and Health.

1.3 Structure of the Contextual Report

The contextual report begins by outlining the project's aims, background, and a description of the developed system. The second section provides an overview of the literature review which were carried out using journals, research papers, books, articles, and other reliable sources. Market research was included as the third section which was carried out to gather reliable information to identify directly and indirectly affecting features, functions, performance, and user experience of proposed system. Next section presents the project planning components, including the Gantt chart and the Work Breakdown Structure (WBS) that detail all the tasks involved in the project. The final section includes method of planning the study including requirement gathering, designing, testing and evaluation.

2. Literature review

This chapter reviews previous research and practice relevant to an AI-enabled smart web application for the IOSH Sri Lanka.

2.1 Existing systems

2.1.1 Commercial and Institutional OHS Management Platforms

Many organizations in different countries use online or cloud-based Occupational Health and Safety Management Systems to manage workplace safety. These platforms work on reporting hazards, recording incidents, completing audits, tracking training, and managing certifications. They compile all safety information into one system, display key statistics through dashboards, send automatic reminders, and keep clear records according to the ISO-45001 requirements (Obasi, 2025). The industries in some countries have systems which include tools to verify training and certification records (Farabi, 2025). Research shows that these platforms save time and make safety records easier to access than traditional paper files or spreadsheets (Jiang, 2024; Obasi, 2025).

2.1.2 Certificate Authentication and Tamper-Resistant Credentials

A common requirement in many systems is to guarantee that digital certificates are genuine, which cannot be changed easily. Following methods such as adding secure digital signatures and verification QR codes to PDF certificates, using central online databases to check certificate details, and applying blockchain or distributed ledger technology to create records that cannot be changed are described in previous studies. New systems use technology to keep a clear record of every document issued to ensure that the digital certificates are real and cannot be changed (Farabi, 2025; Kumar and Tripathi, 2021). Real-world examples from universities and national certification programs reveal that these methods can work effectively, but the legal and administrative acceptance level varies by country or institution (Higher educational certificate QR code studies; Smart credentialing systems, 2024). New systems use technology to keep a clear record of every document issued to ensure that the digital certificates are real and cannot be changed (Kumar and Tripathi, 2021). Recent studies on smart credentials demonstrate that national systems now use QR codes and online lookups which is used to automatically verify certificates and prevent fraud (Smart credentialing and verification studies, 2024–2025).

2.1.3 Context in Sri Lanka

In Sri Lanka, main government organization responsible for OSH is the National Institute of Occupational Safety and Health (NIOSH) under the Ministry of Labour. The NIOSH and some private training institutions offer OSH courses which handle training and certification. According to the public documents and sector reports in Sri Lanka show that these organizations do not use a single, centralized digital system. Many institutions use traditional methods to manage records and administration (NIOSH Sri Lanka; 2024). This highlights the need for a locally appropriate, web-based system for IOSH Sri Lanka. There are well developed modern web platforms for managing safety data and verifying certificates, which can be used in practice. These web platforms can be used in Sri Lanka after obtaining legal approval and by integrating with existing databases. The willingness of the stakeholders to adopt to the new systems is also important for the smooth function of a modern web platform (Obasi, 2025; Farabi, 2025). Workplaces in Sri Lanka are slow to use these modern systems due to poor technology and a lack of clear plans and directions for digital change (Ranasinghe and Dharmasiri, 2022).

2.2 AI-Based Approaches in OSH

2.2.1 Predictive Modelling and Risk Scoring

AI and machine learning are used in OSH to predict possible incidents, to prioritize the workplaces which need inspections first, and detect high-risk trends in past safety records. Research studies reveals that models like ensemble methods and decision-tree algorithms can produce reliable risk scores when they are trained with clean, high-quality labelled data. Research shows high accuracy when working with limited and well-controlled datasets (Shehadeh, 2025; Shehadeh et al., 2025). Complete data and the correct selection of input are the features required for a successful model (El-Helaly, 2024). Use of AI has great possibility to predict accidents. These tools to be effective, AI must combine with machine learning with specific safety expert information rather than using raw data (Hämäläinen, Nenonen and Kivistö-Rahnasto, 2023).

2.2.2 Natural Language Processing (NLP) and Unstructured Report Mining

Natural Language Processing (NLP) methods are used to detect causes, near-miss details, and root issues in free-text incident reports. These techniques are useful to transfer unstructured written reports, which were often difficult to analyze, into useful information. This method can be used to identify patterns and create labelled datasets that can support predictive modelling (El-Helaly, 2024; Fiegler-Rudol, 2025).

2.2.3 Computer Vision and Sensor Analytics

Another AI based approach that can be used in OSH is computer vision, which is useful for automatically checking whether workers are wearing the correct personal protective equipment (PPE) by analysing images or video. IoT devices and sensor-based systems can detect unusual patterns and provide near real-time alerts about environmental conditions or worker health (Bispo, 2024; El Bouchikhi, 2024). There are ethical concerns, including worker privacy, surveillance, consent, and technical issues such as camera placement and the amount of personal data collected.

2.2.4 Human-in-the-Loop and Explainability

Human-in-the-loop approaches is a method in which AI results guide decisions but can be checked, corrected, or overridden by safety professionals. Explainable and easy-to-understand models like logistic regression and decision trees are better methods than complex “black-box” models because they are clearer, easier to trace, and help to build user trust (El-Helaly, 2024; Fiegler-Rudol, 2025).

2.2.5 Implication for IOSH

Current system will start with simple and transparent AI tools. These systems should be user-friendly platform for IOSH to manage environmental and medical certificates and to function administrative processes smoothly. New systems should accommodate prospective forecasting, reminders, and safety features to support decision-making and to apply a secure database with training, certification, communication, and member modules. The throughout the process there should be options for human review and feedback on how the model performs.

2.3 Web-based systems (design patterns and challenges)

2.3.1 Architectural patterns and features

Effective OSH web systems use modular, role-based architectures: a secure backend database (RDBMS or hybrid), RESTful APIs, a responsive front-end (mobile-first for field inspectors), and modular services for certificates, member management, lab results, and analytics (Jiang, 2024; Obasi, 2025). Key features include role and permission management (staff, auditors, members), tamper-resistant certificate generation (unique identifiers, QR codes/hashes), audit logging, exportable compliance reports, and modular connectors for future IoT or lab system integration.

2.3.2 Security, privacy and governance

Privacy and governance are an important factor to be considered in OSH industry. It is necessary to design IoT and AI-enabled OSH systems with proper consent, data minimization, clear data retention policies, and role-based access to protect workers (El Bouchikhi, 2024; El Bouchikhi, M., Weerts, S. and Clavien, C., 2024). It is essential to follow national data protection laws and maintain transparent policies. Strong security and digital checks are required to protect sensitive information in cloud systems from modern online threats (Pal, Jain and Kapoor, 2022).

2.3.3 Usability and adoption constraints

Digital adoption can be increased by improving staff digital literacy, developing connectivity in field sites, and providing favourable organizational changes. Previous research recommends human-centred design, offline data capture options for mobile apps, and a step-by-step adoption process with training and demonstrations (Jiang, 2024; Obasi, 2025).

2.4 Existing datasets

2.4.1 Existing public datasets, their limitations and challenges

There are several public and semi-public workplace injury datasets that researchers commonly use (Kaggle, 2016–2021). There are some limitations in the available datasets. The datasets from the United States or other high-income countries focus on their own local hazards, reporting practices, and regulatory standards. Since Sri Lanka has different working environment, hazards and safety rules, other developed countries data sets are less suitable for use in Sri Lanka (Public Health (George Washington Univ.), 2025; Obasi, 2025). Incident reports also have problems such as missing information, inconsistent coding, and unstructured text, which need corrections and cleaning before analysis (El- Helaly, 2024). The main ethical or legal concern is that some raw datasets contain personal identifiers. These must be handled using privacy-preserving methods before the data can be used (El Bouchikhi, 2024).

2.4.2 Practical dataset strategy for IOSH Sri Lanka

A practical dataset strategy for IOSH Sri Lanka suggest a few key steps: (1) to conduct a data readiness audit to check the available paper records, spreadsheets, and lab logs, and use this to design a standard data format and plan for digitizing the information (Obasi, 2025). (2) to collect the most important fields like certificate IDs, dates, employer details, incident type, and severity. Public datasets can be used for synthetic data or transfer learning, but any models should always be validated using locally labelled data before being used in practice (El-Helaly, 2024). (3) ensure ethical and legal data handling

by anonymizing personal information and recording consent whenever required (El Bouchikhi, 2024).

2.5 Challenges identified in the literature

The literature reveals that there are practical and ethical challenges which affect digital and AI-enabled OSH systems. Poor and fragmented historical records reduce data quality and limit the early usefulness of AI (Obasi, 2025). Privacy concerns are also significant, since sensor and image data can be misused. Consent and transparent governance are essential to minimize the misuse (El Bouchikhi, 2024). Many users do not like to trust AI because black-box models are difficult to explain. Human oversight is

preferred to overcome the problem (El-Helaly, 2024). The legal and security issue is another challenge for issuing digital certificates. The secure system is needed to prevent alterations (Farabi, 2025). Limited digital skills, lack of resources and high cost are challenges in Sri Lanka which can be overcome by training and recruiting skilled personnels to switch from paper to computers (Jiang, 2024; Obasi, 2025).

2.6 Summary and implications for the IOSH Sri Lanka project

The suggestions given by literature for building an IOSH web application are as follows: (1) to focus on the basic administrative features that can give rapid benefits (eg: secure certificate management with QR or hash verification, keeping member records, sending reminders automatically, and having a searchable archive) (Farabi, 2025). (2) to introduce AI tools slowly into the existing system. This can be started with simple rule-based alerts and easy-to-understand risk scores, and later move to advanced prediction or NLP, after the data has been cleaned and labelled properly (El-Helaly, 2024; Shehadeh, 2025). The literature suggests to protect privacy from the beginning by adding consent records, access controls, and a clear data-retention policy before collecting any personal or sensor data (El Bouchikhi, 2024). (3) to create a local data plan by checking available data, digitize most important records first, and to use public datasets only for early training but not for final models (Obasi, 2025).

2.7 Market research

2.7.1 Data collection and analysis

The data was collected through an online survey to identify directly and indirectly affecting features, functions, performance, and user experience of proposed system. The survey form used foe data collection is included in the appendix section (Appendix 1). The survey was conducted among the general population, and fifty-seven participants responded.

2.7.1.1 Age distribution of the participants

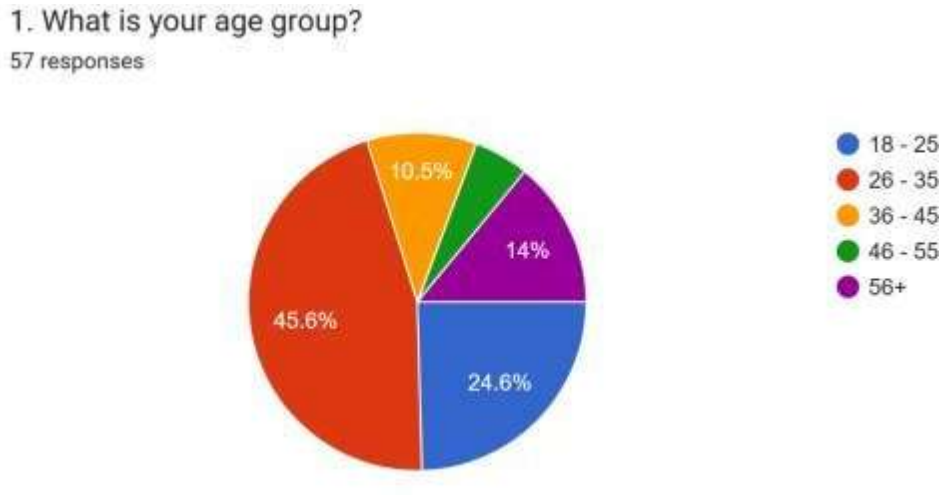

Figure 1: Age distribution of the participants

The pie chart shows the age distribution of 57 respondents. The majority belong to the 26–35 age group (45.6%), followed by aged 18–25 (24.6%). Respondents aged 56 years and above account for 14.0% and the 36–45 age group represents 10.5%. A small proportion falls within the 46–55 age group.

2.7.1.2 Occupational distribution of the participants

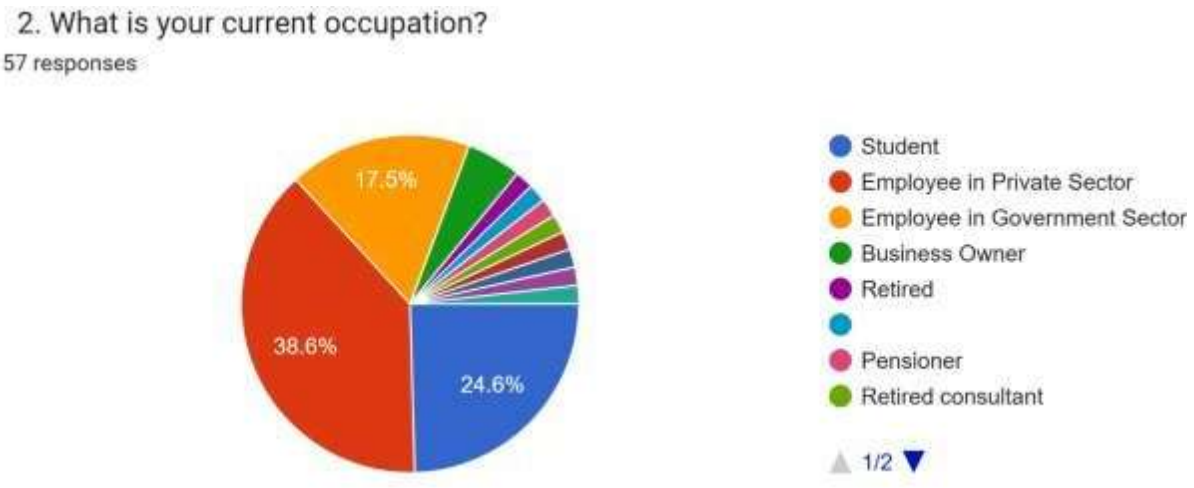

Figure 2: Occupational distribution of the participants

The occupational distribution of 56 respondents is given in Figure 2. The highest proportion includes employees in the private sector (38.6%), followed by students (24.6%). Employees in the government sector constitutes 17.5% of respondents. Another 19.3% represents other occupations, including business owners and retired personal.

2.7.1.3 Awareness of the Institution of Occupational Health and Safety among participants

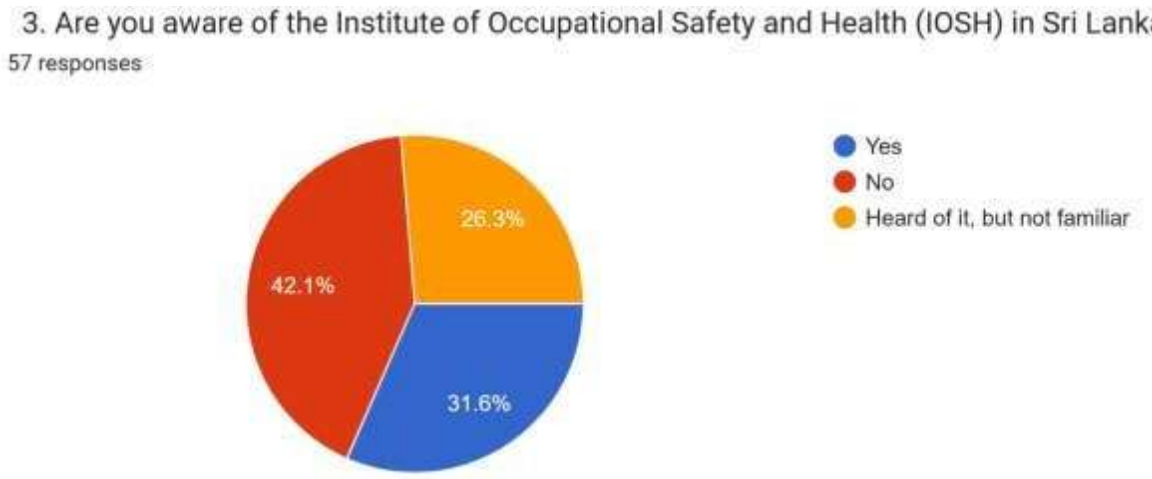

Figure 3: Awareness of the Institution of Occupational Health and Safety among participants

Figure 3 shows that out of the 57 respondents, 42.1% were not aware of the IOSH in Sri Lanka, 31.6% were aware, and 26.3% had heard of it but were not familiar. This indicates low overall awareness of IOSH.

2.7.1.4 Perception on importance of occupational safety and health in workplace among participants

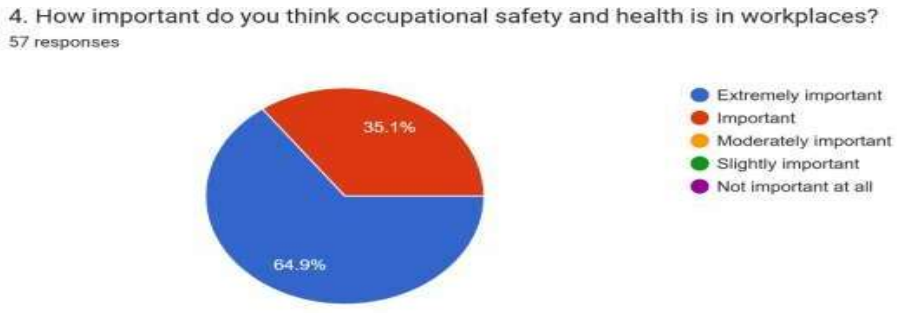

Figure 4: Perception on importance of occupational safety and health in workplace among Participants

. The overall perception of respondents indicated that the occupational safety and health is an important factor in workplace Among the 57 respondents, 64.9% considered occupational safety and health to be extremely important, and 35.1% considered it important.

2.7.1.5 Usage of online platform to access occupational safety and health activities among participants

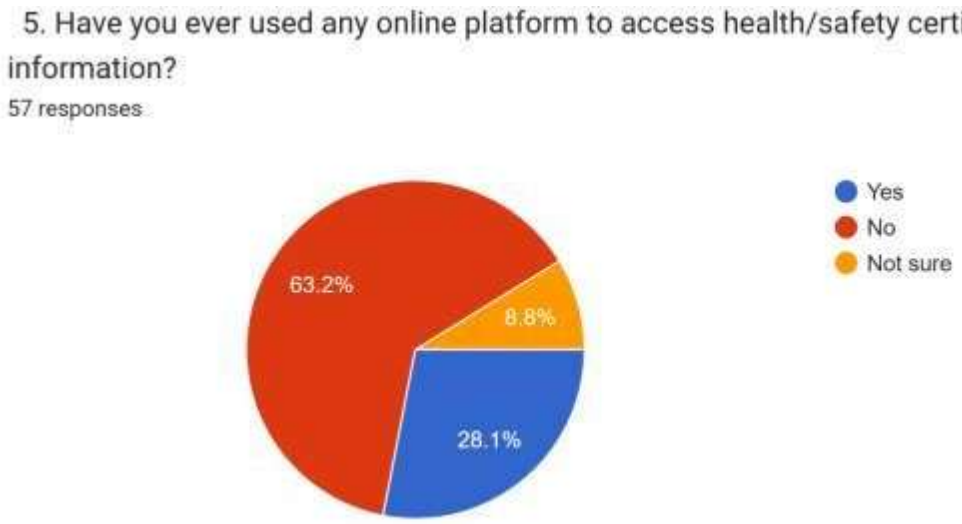

Figure 5: Usage of online platform for accessing occupational safety and health activities among participants

Figure 5 shows that among the 57 respondents, 63.2% had not used any online platform to access safety and health activities, 28.1% had used online platforms, and 8.8% indicated that they were not sure. This indicates the limited use of online resources for safety and health activities.

2.7.1.6 Challenges to access occupational safety and health services

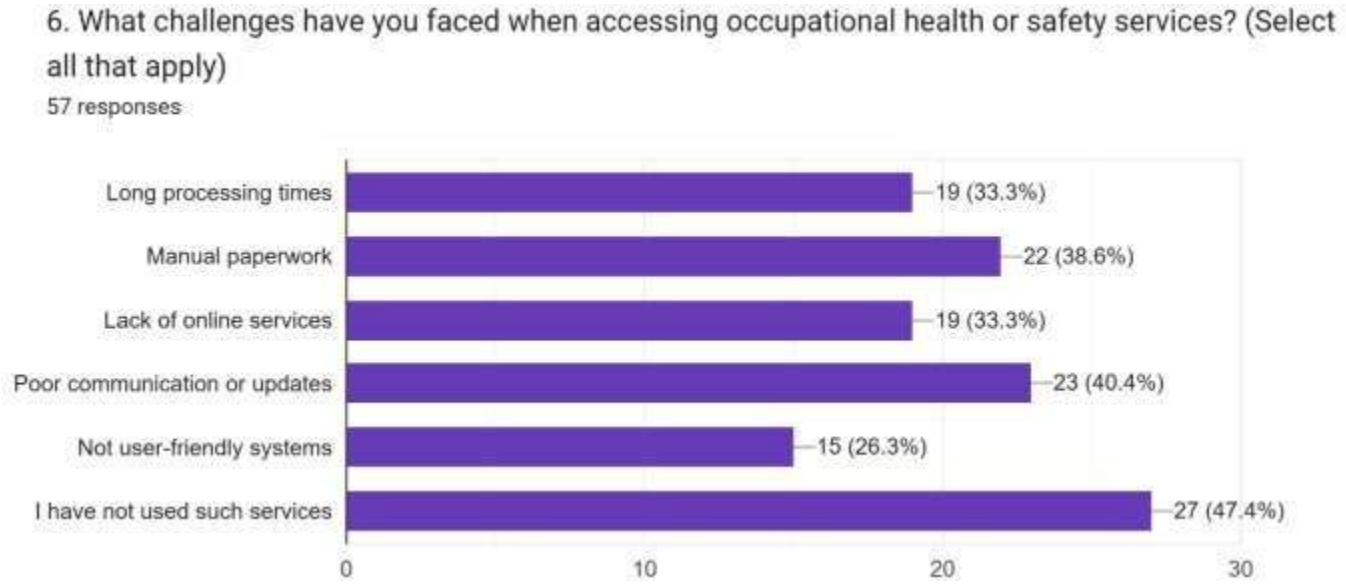

Figure 6: Challenges to access occupational safety and health services

Among the 57 respondents, 27 (47.4%) responded that they have not used occupational safety and health services. Among those who have used the services, the main challenges reported were poor communication or lack of updates (n=23, 40.4%) and manual paperwork (n=22, 38.6%). Long processing times and lack of online services were each reported by 19 (33.3%) participants. Non–user-friendly systems were the least reported challenge (n=15, 26.3%). According to the results participants have given more than one response.

2.7.1.7 Perception on AI-based platform for occupational safety and health services

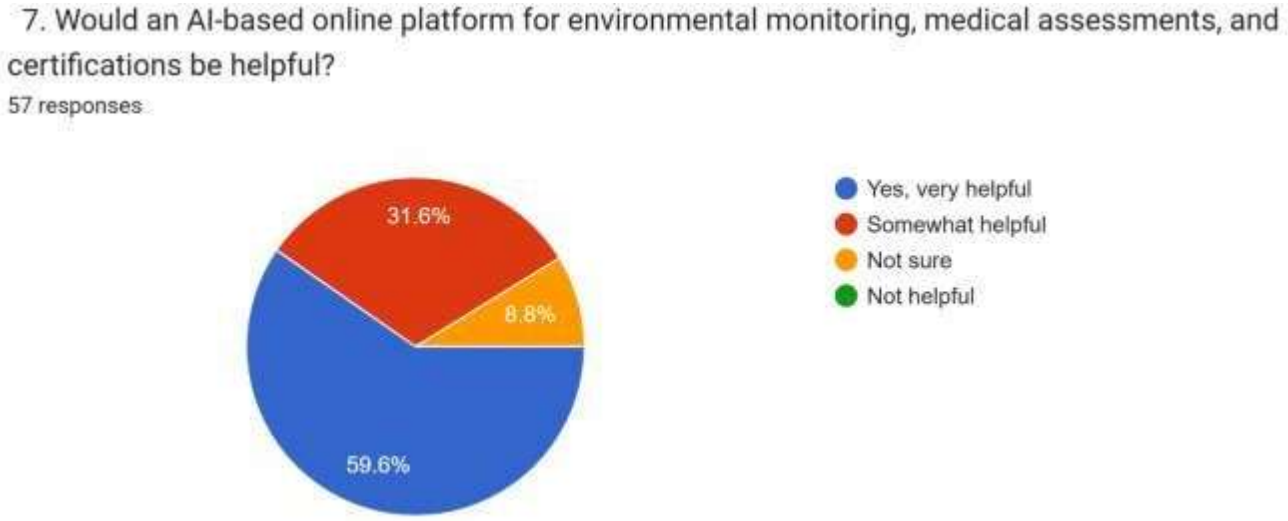

Figure 7: Perception on AI-based platform for occupational safety and health services

Among 57 respondents, the majority thought that an AI-based online platform would be helpful (59.6%), while 31.6% considered it somewhat helpful. Only 8.8% thought it would not be helpful. None of the participants reported that it would be completely unhelpful.

2.7.1.8 Perception on usefulness of smart web application on occupational safety and health services

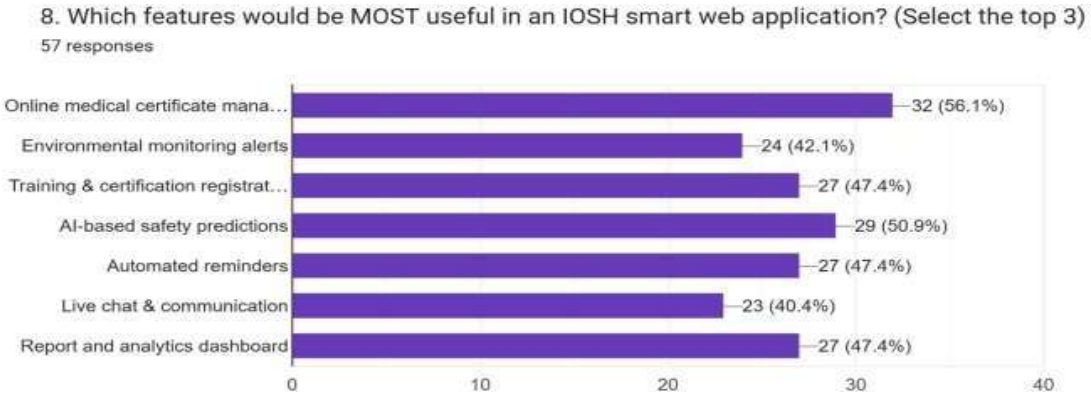

Figure 8: Perception on usefulness of smart web application on occupational safety and health services

The most preferred feature of an IOSH smart web application among 57 respondents was online medical certificate management (n=32, 56.1%), followed by AI-based safety predictions (n=29, 50.9%) and training and certification registration (n=27, 47.4%). Automated reminders (n=27, 47.4%) and a report and analytics dashboard (n=27, 47.4%) were also considered as useful features, while environmental monitoring alerts and live chat/communication were selected by 24 (42.1%) participants.

2.7.1.9 Perception on Importance of real-time safety alerts for a work place

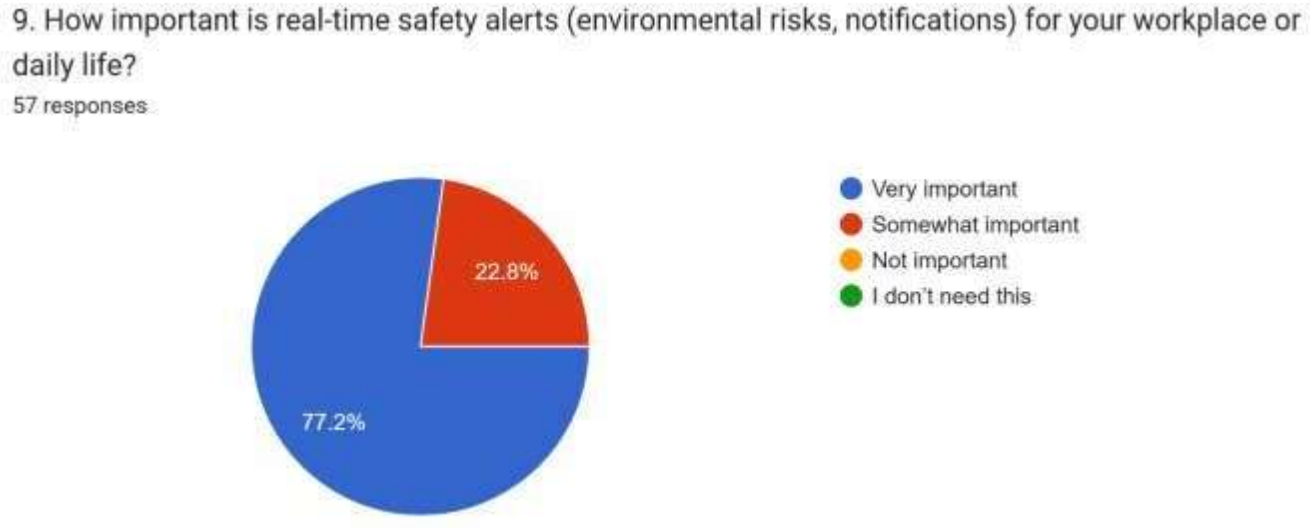

Figure 9: Perception on importance of real-time safety alerts for a work place

Out of 57 respondents, the majority considered real-time safety alerts are very important (77.2%), while 22.8% thought they were somewhat important. No respondents indicated that safety alerts were not important or unnecessary.

2.7.1.10 Perception on use of web application to manage all occupational safety and health services in one place

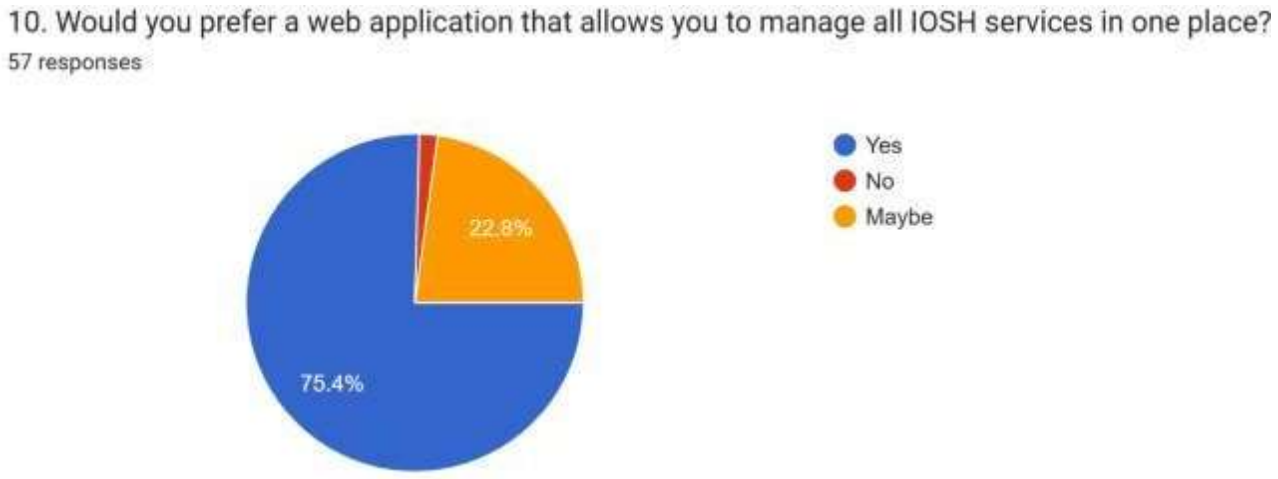

Figure 10: Perception on use of web application to manage all occupational safety and health services in one place

Out of 57 respondents, the majority (75.4%) preferred a web application that allows management of all IOSH services in one place. Nearly 22.8% were unsure ("maybe"), while only a very small proportion thought that they would not prefer the use of web application.

2.7.1.11 Device preference to access online services

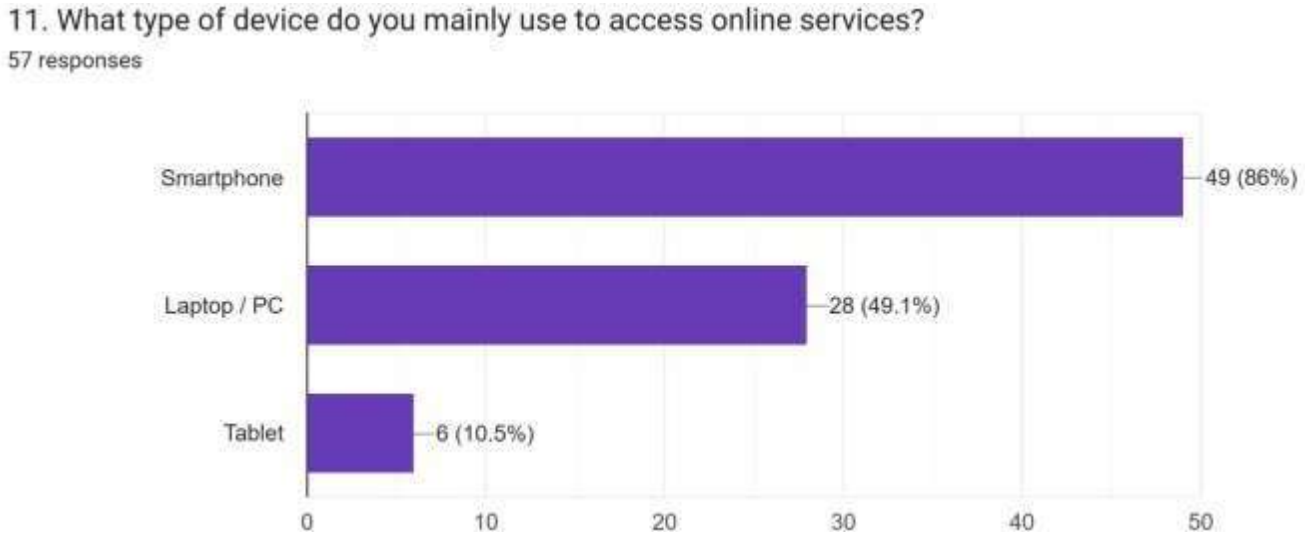

Figure 11: Device preference to access online services

Majority of the respondents 49 (86.0%) prefer to use smartphones to access online services. Laptops or PCs are also commonly used, selected by 28 (49.1%) of respondents, while tablets are the least frequently used device (n= 6, 10.5%). The results indicate that respondents were allowed to select more than one main device (many people use multiple devices regularly for online services) because the total percentages exceed 100%.

2.7.1.12 Expectations from an online service platform

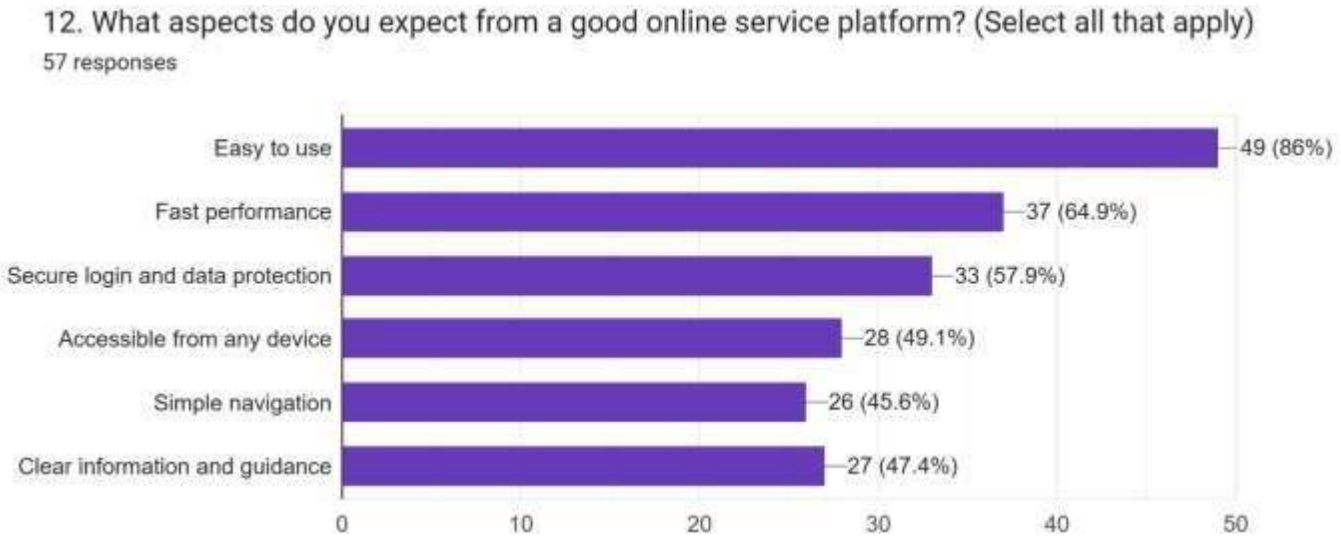

Figure 12: Expectations from an online service platform

The user's expectation from a good online service platform indicates that the ease of use is the most important factor (n=49, 86.0%). Second highest expectation is fast performance (n= 37, 64.9%), followed by secure login and data protection (n=33, 57.9%). Nearly half of the respondents expect accessibility from any device (n=28, 49.1%) and clear information and guidance (n=27, 47.4%), while simple navigation is also considered important, selected by 26 (45.6%) participants. This indicates a strong user preference for platforms that are in-built, quick, secure, and versatile.

2.7.1.13 Trust on an AI-powered system to provide safety recommendations at work place

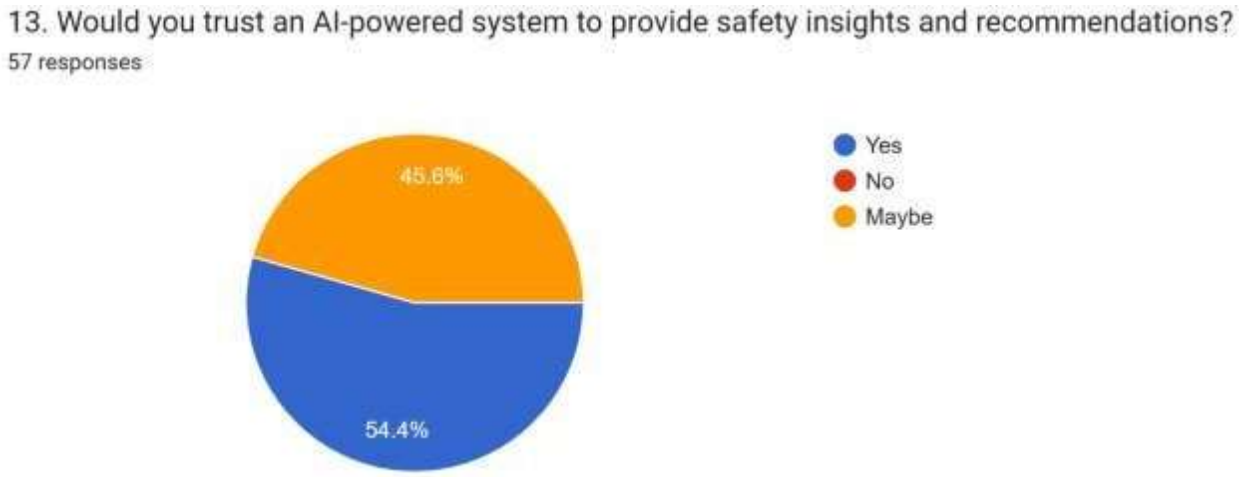

Figure 13: Trust on an AI-powered system to provide safety recommendations at work place

The results show a majority of respondents (54.4%) thrust on an AI-powered system to provide safety recommendations at work place, while around a half of the respondents (45.6%) indicating uncertainty by selecting "Maybe." The data suggests that the people have the trust on AI-driven safety systems to provide safety recommendations, but building better confidence among users is a requirement.

2.7.1.14 Perception on digitalization of occupational safety and health services on efficiency of work

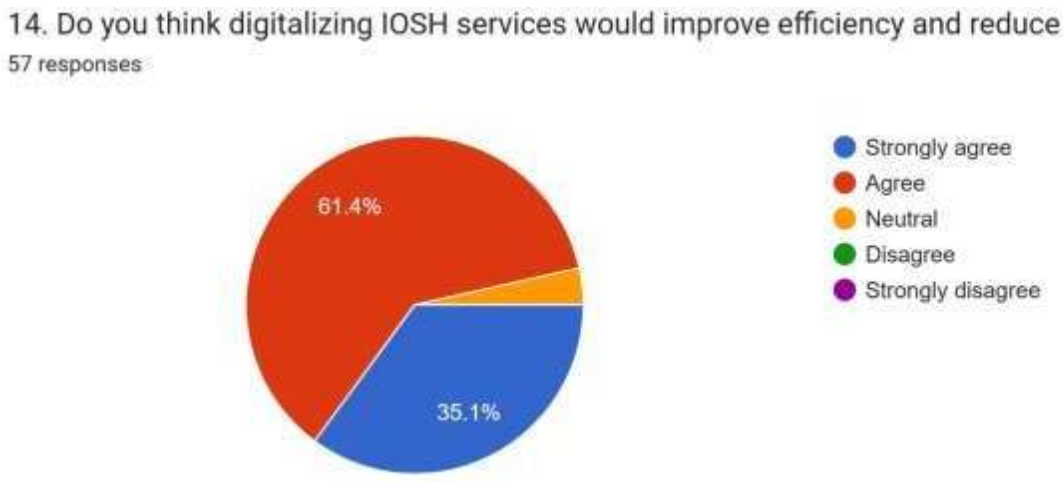

Figure 14: Perception on digitalization of occupational safety and health services on efficiency of work

The survey results indicate strong positive perception among respondents towards digitalizing IOSH services. Majority of respondents (61.4%) agree on digitalization of IOSH services improves the efficiency of work, while 35.1% strongly agree on digitalization would improve efficiency. Very small percentage (3.5%) expressed as “neutral”. This suggests the respondents have general confidence that digitization would lead to significant operational improvements.

2.7.1.15 Suggestions for improving the proposed IOSH smart web application

An open-ended question was asking for suggestions for improvement of the proposed systems. Fourteen responded answered the question and appreciate the project as a good initiative. One suggestion is to do a pilot before implementing in large scale.

2.7.2 Conclusion of the Market Survey findings

The survey findings reveal a clear gap between the importance of OSH and the existing level of awareness, accessibility, and digital utilization of OSH services in Sri Lanka. The results show that the awareness of IOSH is relatively low, however there is strong support for the digitalization of OSH services. Majority of the respondents believe that digital and AI-enabled platforms would improve efficiency and service delivery of IOSH.

The results indicate a user demand and a preference for a centralized, user-friendly, and secure smart web application which can integrate key OSH services in one place. The preference for mobile access, real-time safety alerts, and AI-driven features supports the relevance and implementation of the proposed system. The survey strongly justifies for developing a digital, AI-assisted IOSH platform, and highlight the importance of improving awareness, usability, and trust to ensure effective adoption.

2.8. Gaps in existing research

2.8.1. Lack of localized institutional integration

Current research in OSH management mainly focuses on high-level industrial sensors or wearable IoT devices used in developed countries. But there is a gap in research about the digitalization of OSH institutions like IOSH Sri Lanka. The present systems are designed for single-company use but they are not integrated. There is a need of a service-providing body that can manage heterogeneous data (medical, environmental, and educational) across several different member organizations.

2.8.2. Inefficiency of fragmented manual Workflows

The digital transformation is a global trend but still the Sri Lankan OSH services continue dependent on manual, paper-based documentation. The gaps identify by manual workflows are: (1) The "Data Silo" Gap; not having a combined platform that link the gap between laboratory results (environmental testing), clinical data (medical exams), and administrative status (certification). Modern data tools can gather disorganized data from different places and turn it into valuable information. This will help to connect clinical, environmental and laboratory data and IOSH administrative systems work together for better management (Sarker, 2021). (2) The Speed Gap; manual methods take time to issue medical certificates which result in high "lead times" for certificate issuance.

2.8.3. Absence of AI-Driven proactive safety management

A major gap in available OSH applications in Sri Lanka is the lack of predictive adaptability. Present software is "reactive" since it records an accident after it occurs and it can store a certificate after it is issued. Another gap identified is the forecasting gap, in which there is inadequate integration of AI-driven forecasting to predict risk or send "Smart Reminders." There is a “Decision-Support Gap” in the existing system since data driven tools are not available for safety officers to identify sector specificity (e.g., construction vs. manufacturing) of health hazards in real time.

2.8.4 Limitations in accessibility and reporting standards

Current OSH platforms are often "closed systems" with complex interfaces, in which specialized IT training is needed to operate them. In the Sri Lankan situation, there is a gap in User-Centric design for non-technical safety officers and members. There is a “Reporting Gap” in which the existing National reporting systems is "under-reporting" due to the difficulty of filing manual paperwork. Another gap identified is “Digital Literacy Gap”, which shows that current Small and Medium Enterprises in Sri Lanka faces problem in use of standard international OSH software due to high cost and complexity in implementation.

2.9. Similar systems available

2.9.1. Safety Culture

The Safety Culture is a mobile-first safety platform which allows industry to digitize their paper checklists and conduct inspections via smartphones. Automated report generation, real-time analytics, and a massive library of industry-standard templates are the key features. It shows the effectiveness of transforming away from paper-based audits to digital data collection. This is a primary goal for IOSH Sri Lanka.

2.9.2. VelocityEHS

The VelocityEHS is an enterprise-level EHS (Environment, Health, and Safety) software which uses AI to offer predictive insights into workplace risks. AI-powered "Predictive Solutions," chemical management, and automated compliance tracking are the key features of VelocityEHS. The "prospective forecasting" and "smart reminders" are examples of the high-end capabilities seen in VelocityEHS.

2.9.3. EcoOnline

It is a comprehensive SaaS platform designed to manage chemical safety, environmental impact, and employee health records in one centralized portal. Centralized data repository, role-based access control, and QR-code-based incident reporting are key features of the EcoOnline. This system focuses on removing "data silos" by keeping medical, training, and environmental data in a single secure location.

2.10. How this project fills the gap

The proposed IOSH digital system will be designed to provide fragmented manual workflows with a centralized, AI-enabled digital ecosystem. The project plans to develop a combined data management hub to link the gap between laboratory testing, medical examinations, and administrative certification.

Proposed project incorporates a secure database that ensures real-time data synchronization and high accuracy across all departments of IOSH. This will replace paper-based files and separate spreadsheets.

The project is focus on proactive safety management through AI-driven automation. Current OSH practices in Sri Lanka are reactive; industries are dealing with safety compliance only when certificates expire or incidents occur. The project plans to fill this gap by using Machine Learning algorithms to provide prospective forecasting of safety trends and automated "Smart Reminders" for certificate

renewals.

The project plans to introduce digital transparency and accessibility. By providing a dedicated portal for members, organizations can track their safety status, download verified certificates via QR code authentication, and access safety training resources rapidly. This reduces the need for physical visits and the "lead time" for service delivery.

Main proposed changes by the project can be given as, from manual to automated (from slow paper-based handling to prompt digital workflows), from reactive to predictive (AI uses to forecast safety risks and automated alerts will be sent before compliance issues arise), from isolated to integrated (links medical, environmental, and administrative data into one "Single Source") and enhanced security (implements role-based access and digital verification (QR codes) to prevent certificate falsification).

3. Project Plan

3.1. Project Overview

The main objective of the project is to design and implement an AI-enabled Smart Web Application for IOSH Sri Lanka. This will change the institution from manual, paper-based workflows to a modernized digital system which acts as a centralized hub for managing environmental testing, medical examinations, and professional certifications.

By using AI and Machine Learning, the application will provide proactive features like predictive risk forecasting and automated "Smart Reminders" for certificate renewals. The platform is designed as a secure, cross-platform web application, ensuring that IOSH staff, corporate members, and safety professionals can access real-time data from any location.

The project consists of seven key phases:

1. Planning.
2. Requirement gathering and Analysis.
3. System design.
4. Implementation.
5. Testing.
6. Evaluation.
7. Documentation.

The details of each phase are given in the Work Breakdown Structure (Figure 15).

3.2. Work Breakdown Structure

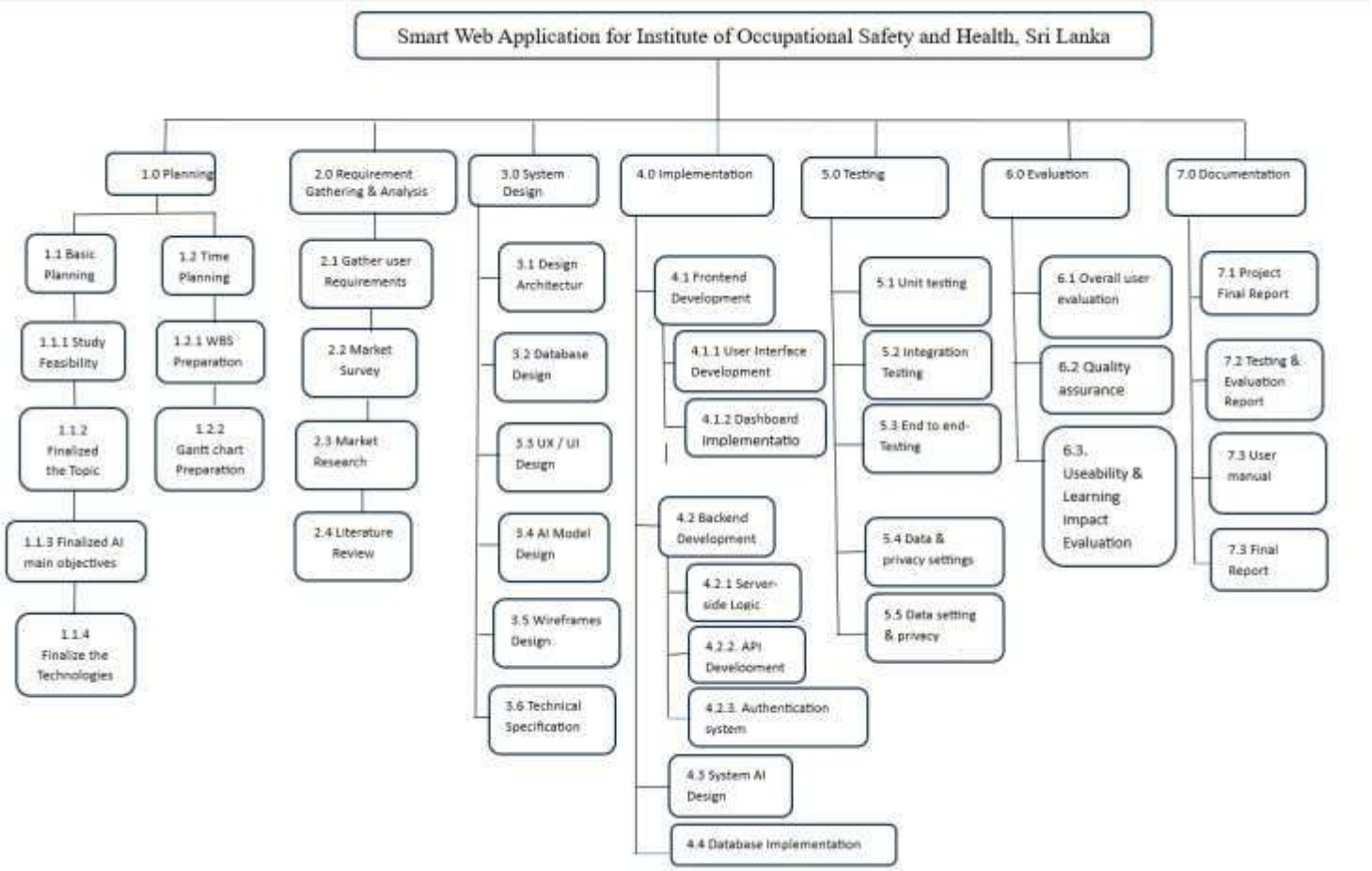

Figure 15: Work Breakdown Structure

3.3 Gantt Chart

The Gantt chart will represent the timeline of tasks and their relevant times over the project period. It will cover all major phases from the beginning to the completion of the project.

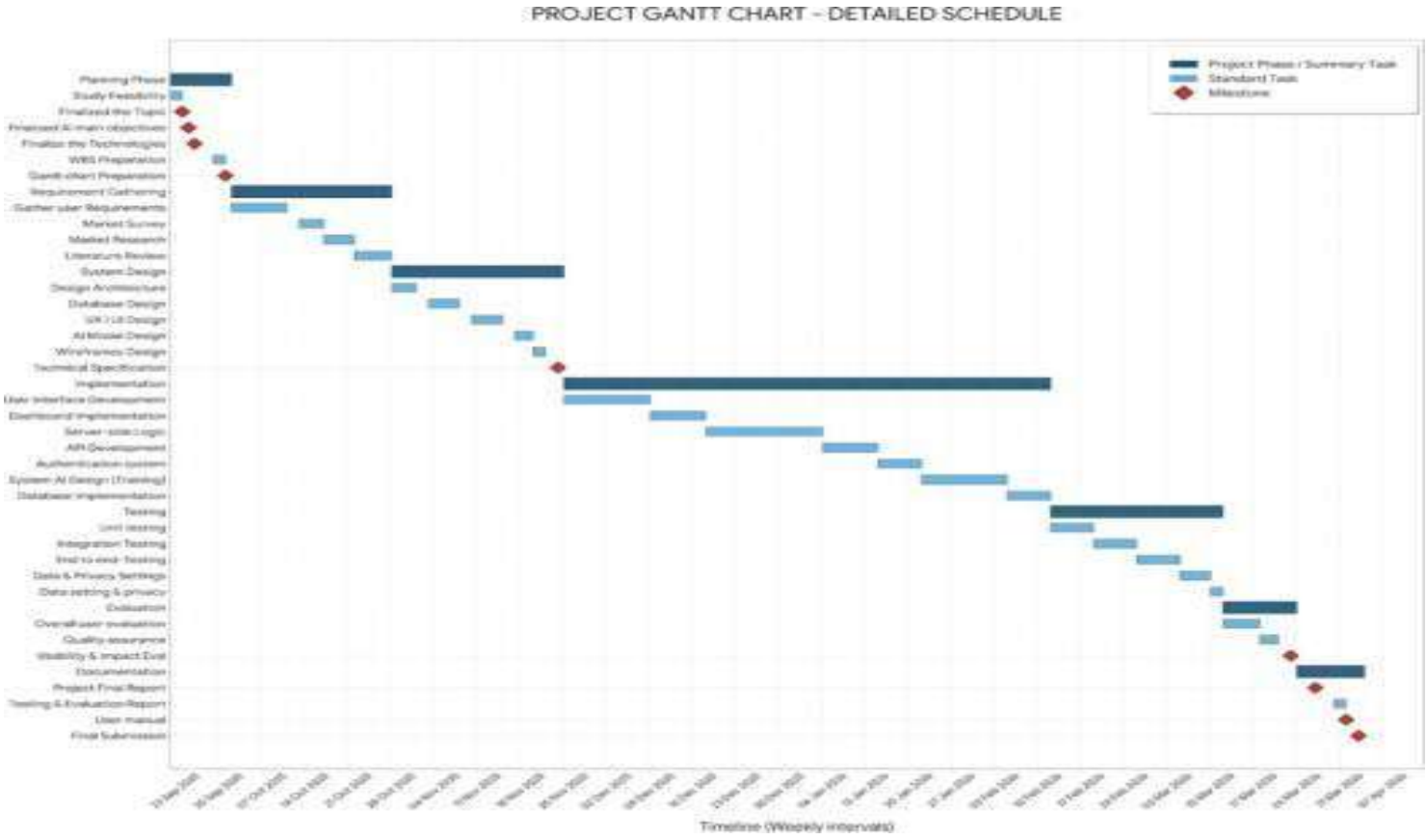

Figure 16: Gantt chart of the Project on Smart Web Application for IOSH

4. Planning

Project planning is the development of different phases of total project which include institutional research, data gathering from manual records, AI model training for safety forecasting, UI/UX development for administrative efficiency, and backend architecture design. In the planning stage, a detailed description of tasks is provided and arranged into a chronological timeline which includes a clear understanding of the duration and depth of each task. For effective project management, industry-standard tools like Jira or ClickUp will be utilized to track progress.

4.1. Methodology

The project to develop the AI-enabled Smart Web Application for IOSH Sri Lanka is planning to build as functional parts which can be refined through repeated cycles allowing for continuous adaptations and improvements by incorporating feedback at each stage. This methodology was selected due to its adaptability and effective risk management when handling sensitive safety data. It has a capacity to provide continuous improvement through real-time feedback from IOSH staff and safety officers of the industries. It will result a better final product suitable for the requirement for the IOSH. The reasons for using this type of methodology are given below:

1. Flexibility and adaptability; the project incorporates machine learning components, a centralized web portal, and administrative modules. The manual IOSH processes need to be digitalized during the project. Using a repeated cyclical method permits the system to be adjusted and upgraded throughout the development and testing phases.
2. Reduced risk in data management and deployment; data handing can cause errors and to overcome this, small, manageable increments can be developed and perform unit testing on each module (eg: The Medical Record module or Certification engine). This prevents failures in the final deployment which helps to confirm that certificates and safety reports are accurate and legally compliant.
3. Support for AI forecasting cycles; the development of the AI model for safety forecasting is a step-by-step process. A simple model will be built to track certificate expiries at the beginning and later it will be improved by adding new data and refining algorithms based on feedback to predict workplace safety trends.
4. Stakeholder and user feedback integration; this application is designed for IOSH administrative staff, medical officers, and external members since their feedback is essential. An iterative method permits to display working versions of the software to users.

5. Improved collaboration between modules; the AI engine, the member database, and the frontend portal will be formed in parallel. This permits all parts of the IOSH system to work together smoothly and permit the team to test the incorporation of laboratory results with certificate generation faster.
6. Efficient use of time and resources; project can be delivered in phase basis. Then the IOSH can begin utilizing high-priority features (like the digital member database) while the more complex AI forecasting tools are formed in the next cycle.

4.2. Planning the Artifact

Planning the artifact involves outlining the overall strategy, methods, and processes required to build the proposed AI-enabled Smart Web Application for IOSH Sri Lanka. This is the phase between the initial concept of improving occupational safety management and the practical implementation by defining how the centralized digital system will be developed and evaluated.

It includes selecting the appropriate iterative methodology, analyzing the specific requirements for medical and environmental data management, and designing a strong system architecture and user interface. Technical tools which can be used are Python for AI forecasting and React for the web dashboard. These technical tools are selected based on the project's need for security, efficiency, and scalability.

Each step of the development, from the digitization of manual records and data preparation to the final deployment of the member portal, is planned with a clear timeline and defined responsibilities. Proper planning of the artifact is needed to ensure the project progresses in a structured, logical, and successful manner. Final objective is to provide a reliable digital system for the IOSH.

Key components of artifact planning are strategy (transitioning from paper-based files to a cloud-based relational database), methods (using AI algorithms to automate the monitoring of safety certificate validity), design (creating a professional, accessible UI that satisfies both IOSH administrative staff and external corporate members) and evaluation (defining achievement metrics based on the reduction of certificate processing time and the accuracy of AI-driven safety alerts).

4.3. Requirement and Analysis

The main requirement which includes software and hardware requirements for the proposed system is given below in Table 1 and Table 2.

Table 1: Hardware requirements for the proposed system

Requirement	Description
PC / Laptop (Development)	Minimum 16GB RAM, Intel i7 Processor, and SSD storage to handle local server hosting and AI model training.
Server / Cloud Hosting	AWS, Google Cloud, or Azure for hosting the web application, centralized database, and AI forecasting engine.
Workstations (IOSH Staff)	Standard office PCs with modern web browsers (Chrome/Edge/Firefox) to access the administrative dashboard.
Mobile Devices	Smartphones/Tablets for field officers to access the portal and upload environmental test data on-site.
Data Storage	Scalable cloud storage for archiving digital certificates, medical records, and high-resolution laboratory reports.
Internet Connection	High-speed, stable internet connection for real-time data synchronization IOSH central server and industries.

Table 2: Software requirements for the proposed system

Requirement	Description
Operating System	Windows 10/11 Linux (Ubuntu) for the development and server environments.
Frontend Framework	React native/React.js or Angular for building a responsive, secure, and user-friendly web interface.
Backend Framework	PHP/Python (Django/FastAPI) to facilitate the integration of Machine Learning models and secure API management.
Database Management	PostgreSQL or MySQL for robust, relational storage of member data and certification records.
AI/ML Libraries	Scikit-learn and Pandas for developing the predictive forecasting and automated alert modules.
Security/Authentication	JWT (JSON Web Tokens) and SSL encryption to ensure data privacy and secure user login.
Development Tools	Visual Studio Code (IDE), Postman (API testing), and Git for version control, XAMPP/WAMP – local set up PHP and MySQL

Selecting a modern web framework is very important since it will help the system to use easily and ensures it works perfectly on the different devices mentioned in the survey (Garrett, 2011; Tilkov and Vinoski, 2010).

Table 3: Functional requirements for the proposed system

Requirement	Description
Member Registration and Login	Permit IOSH and safety professionals to create accounts and safely access their profiles.
Data Entry and Upload	Prepare interfaces for IOSH staff to input medical examination results and upload environmental laboratory test reports.
Automated Certification	Generate digital, verifiable safety certificates (with QR codes) automatically.
AI Safety Forecasting	Machine learning is used to analyze past data and predict potential workplace hazard trends.
Smart Notifications	Send automated email/SMS alerts to members before their safety certifications or medical records expire.
Administrative Dashboard	Can visualize a centralized view for IOSH management to monitor pending assessments, issued certs, and revenue.

Table 4: Non-Functional requirements for the proposed system

Requirement	Description
Security and Privacy	Need to use end-to-end encryption to protect sensitive medical records and institutional data.
Scalability	The application is built on cloud infrastructure to handle a large number of members and data.
High Model Accuracy	The AI forecasting and reminder engine need to maintain an accuracy rate of over 95% to avoid false alerts.
High Performance	The web portal and report generation should be fast.
Usability	The interface must be intuitive, allowing non-technical IOSH staff to manage data with minimal training.
Availability	The system must be accessible 24/7. Then the members can verify certificates at any time.

4.4. Design and Implementation

The design phase consists of system architecture diagrams, user interface wireframes for the web-based administrative portal and the member dashboard, and complex database schemas. A modular structure is utilized to separate needs like AI risk prediction, user management, and report generation.

The backend handles all API requests, secure data storage, and the integration of the Machine Learning forecasting model. React JS is used for the frontend and it will ensure high performance. Pre-trained data models are used for trend analysis which help to create a powerful AI engine. The application supports future scalability and administrative flexibility with strict version control and a structured design.

4.5. Testing and
4.6. Evaluation

Testing and evaluation of the IOSH Smart Web Application are essential to certify it operates with high accuracy, performs efficiently, and reach the objectives of the IOSH. This includes unit testing for individual modules (like the login or upload features), integration tests for the AI and database connection, and User Acceptance Testing (UAT) specifically with IOSH staff members.

Evaluation is conducted by collecting feedback from medical officers and safety auditors to certify the workflows match real-world procedures. A load testing is performed to ensure the backend remains stable when several customers access the portal simultaneously. This comprehensive approach guarantees a reliable, secure, and user-friendly application for IOSH.

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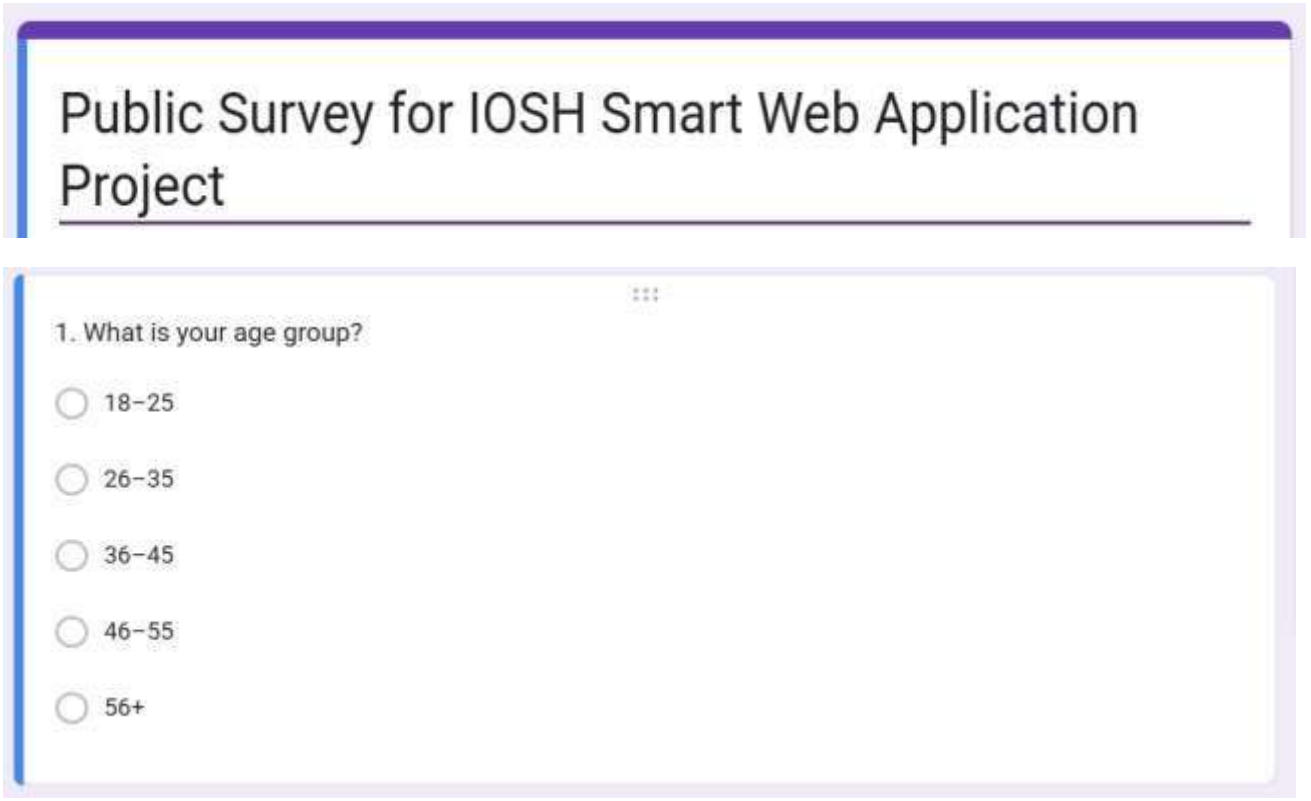
Appendix 1 - Questioner



Public Survey for IOSH Smart Web Application Project

1. What is your age group?

- 18–25
- 26–35
- 36–45
- 46–55
- 56+

2. What is your current occupation?

- Student
- Employee in Private Sector
- Employee in Government Sector
- Business Owner
- Other:

3. Are you aware of the Institute of Occupational Safety and Health (IOSH) in Sri Lanka?

- ○ Yes
- ○ No
- ○ Heard of it, but not familiar

4. How important do you think occupational safety and health is in workplaces?

- ○ Extremely important
- ○ Important
- ○ Moderately important
- ○ Slightly important
- ○ Not important at all

5. Have you ever used any online platform to access health/safety certificates or training information?

- ○ Yes
- ○ No
- ○ Not sure

6. What challenges have you faced when accessing occupational health or safety services? (Select all that apply)

- [ ] Long processing times
- [ ] Manual paperwork
- [ ] Lack of online services
- [ ] Poor communication or updates
- [ ] Not user-friendly systems
- [ ] I have not used such services

7. Would an AI-based online platform for environmental monitoring, medical assessments, and certifications be helpful?

- ○ Yes, very helpful
- ○ Somewhat helpful
- ○ Not sure
- ○ Not helpful

8. Which features would be MOST useful in an IOSH smart web application? *
(Select the top 3)

- [ ] Online medical certificate management
- [ ] Environmental monitoring alerts
- [ ] Training & certification registration
- [ ] AI-based safety predictions
- [ ] Automated reminders
- [ ] Live chat & communication
- [ ] Report and analytics dashboard

9. How important is real-time safety alerts (environmental risks, notifications) for your workplace or daily life?

- ( ) Very important
- ( ) Somewhat important
- ( ) Not important
- ( ) I don't need this

10. Would you prefer a web application that allows you to manage all IOSH services in one place?

- ○ Yes
- ○ No
- ○ Maybe

11. What type of device do you mainly use to access online services? *

- ☐ Smartphone
- ☐ Laptop / PC
- ☐ Tablet
- ☐ Other: _____

12. What aspects do you expect from a good online service platform? *
(Select all that apply)

- [ ] Easy to use
- [ ] Fast performance
- [ ] Secure login and data protection
- [ ] Accessible from any device
- [ ] Simple navigation
- [ ] Clear information and guidance

13. Would you trust an AI-powered system to provide safety insights and recommendations?

- ( ) Yes
- ( ) No
- ( ) Maybe

14. Do you think digitalizing IOSH services would improve efficiency and reduce delays?

- ○ Strongly agree
- ○ Agree
- ○ Neutral
- ○ Disagree
- ○ Strongly disagree

15. Any suggestions for improving the proposed IOSH smart web application?
(Short answer)

Long-answer text