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Work Accident Reduction through the Use of the Lean Six Sigma Methodology at a Selected Hospitality Facility in Pasay City

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Abstract

Aim: Occupational health and safety (OSH) is critical in safeguarding workers from workplace hazards, preventing occupational diseases, and promoting overall well-being. In the Philippines, Republic Act 11058, enacted in 2017, establishes comprehensive OSH standards, including workers' rights to a safe working environment, the right to refuse unsafe work, and access to personal protective equipment. Despite these regulations, significant workplace accidents and injuries persist, with 38,235 accidents and 46,283 injuries reported in 2017, primarily in the manufacturing sector. The hospitality industry, which includes tourism, gastronomy, entertainment, and accommodation, also faces unique health and safety challenges due to diverse and frequent interactions with potential hazards. Ensuring the health and safety of workers in all work-related processes is a fundamental objective of occupational health and safety (OSH) practices. This research explored the application of the Lean Six Sigma methodology to enhance OSH practices within a hospitality facility in Pasay City.

Methodology: An applied research methodology was used in the study. Applied research, according to Bakke and Claudio 2023, is a form of systematic inquiry that focuses on practical, real-world problems. The goal is to solve specific issues or improve existing processes and practices by applying existing theories, knowledge, and methodologies. applied research is directly relevant to practical applications in various fields such as business, education, engineering, health, and social sciences, (Bakke & Claudio, 2023; Drohomeretski et al., 2014). In addition, this study implemented the Lean Six Sigma methodology to reduce work accidents at the selected hospitality facility.

Results: The results of this study are divided into five phases, aligned with the DMAIC process of the Lean Six Sigma Methodology, incorporation the necessary tools for process definition and assessment. The first phase, Define, established the scope of the problem by identifying key areas of concern. The second phase, Measure, presented and analyzed Company X's Monthly severity rate and Accident Lost Days per Million for the year 2022. The third phase, Analyze, examined the occurrence of workplace accidents and illnesses, identifying general trends and highlighting potential areas for improvement in the company's accident and incident management practices. The fourth phase, Improve, translated the identified root causes into specific objectives and implemented enhancements to company's accident reduction program. Finally, the Control phase outlined the activities and workplace programs that must be sustained to ensure the continued achievement of workplace accident reduction objectives.

Conclusion: Through an in-depth analysis of the root causes, the study identified critical areas for improvement. The development and implementation of a work accident reduction program based on Lean Six Sigma principles led to significant enhancements in working conditions and accident prevention measures. Ultimately, the study demonstrated that the program effectively controlled the occurrence of accidents and reduced their severity, contributing to a safer work environment in the facility.

Keywords: Occupational health and safety, Hazards, Lean Six Sigma, Workplace accident & hospitality

INTRODUCTION

All workers should have their health and safety at work safeguarded, as they conduct all work-related processes. In this regard, the field of occupational health and safety (OSH) is developed, which primarily aims to

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protect workers from hazards that may arise in the workplace, prevent the occurrence of occupational diseases, promote overall health and well-being while at work, and place the worker in a working environment adapted to their capabilities. To ensure that OSH is adequately and appropriately implemented in all workplaces, all countries have laws that translate to policies, programs, and services that ensure OSH provision and maintenance. The Philippines, specifically, has Republic Act 11058, which is the country's OSH law (Candelario et al., 2024). Implemented in 2017, the law delineates general OSH provisions, among which are those that reiterate the worker's rights to a safe workplace, including the right to refuse unsafe work, the right to report accidents, and the right to the provision of personal protective equipment.

Despite implementing the OSH law, and workplaces in the country having their own OSH policies and programs that are compliant and committed to decreasing workplace accidents and injuries, there is still an effort needed to protect workers from unsafe work processes (Lu, 2022). This same study cites the incidence of occupational accidents at 38,235 cases in 2017 and a further higher number of occupational injuries at 46,283 cases, with the manufacturing industry reporting the bulk of these accidents and injuries. Moreover, the study also mentions that the leading causes of occupational injuries among workers were stepping on, striking against, or being struck by objects (excluding falling objects).

The hospitality industry encompasses various sectors, including tourism, gastronomy, entertainment, and accommodation facilities, which provide service trades to their clientele (Agunos et al., 2022). This industry is not exempt from workplace health and safety hazards, as they can be exposed to these in all aspects, whether from handling food, serving guests, or cleaning their premises (Huang et al., 2018; Rosemberg et al., 2019). Therefore, a comprehensive Occupational Safety and Health (OSH) program must be established in these industries to cover all health and safety risks identified by the safety organization of each facility. This program should be both responsive and proactive, addressing these risks effectively and implementing measures to minimize the likelihood of encountering them in the future. In this regard, many comprehensive program planning and implementation methodologies can be used, but one of the most renowned is the Lean Six Sigma method. This fact-driven method focuses on reducing work process variation and enhancing process control while removing non-value-added processes and procedures, thereby promoting an overall standardization of workflow. This protocol explores the application of the Lean Six Sigma methodology in reducing work accidents in a selected hospitality facility in Pasay City, consistent with the facility's effort to commit to improving working conditions through upholding workplace health and safety.

Objectives

The study generally aims to determine the effects of the Lean Six Sigma methodology in the reduction of workplace accidents in a selected hospitality facility in Pasay City. Specifically, the protocol aims to:

1. Define the current conditions relevant to the occurrence of work accidents in the selected hospitality facility.
2. Measure data relevant to the estimation of the severity of work accidents at the facility and its impact on the facility's work processes.
3. Analyze the root causes of persisting work accidents based on the facility's work accident database.
4. Improve working conditions and accident prevention measures through the development of a work accident reduction program; and
5. Determine how the work accident reduction program controlled the occurrence and lowered the severity of workplace accidents in the facility.

METHODS

Research Design

The researcher used applied research in this study. Applied research, according to Bakke and Claudio is a form of systematic inquiry that focuses on practical, real-world problems. The goal is to solve specific issues or improve existing processes and practices by applying existing theories, knowledge, and methodologies. applied research is directly relevant to practical applications in various fields such as business, education, engineering,

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health, and social sciences, (Bakke & Claudio, 2023; Drohomeretski et al., 2014). In addition, this study implemented the Lean Six Sigma methodology to reduce work accidents at the selected hospitality facility.

Population and Sampling

The participants of the study were current employees of Company X involved in the accident cases together with the researcher. This study also included the Health, Safety and Environment (HSE) Managers, Assistant Managers, Supervisors, Safety Officers and company's HSE Committees.

Instrument

The main instruments used by the researcher for data gathering were:

1. Monitoring of accident/ incident reports and records- This instrument involves systematically tracking, recording, and analyzing incidents or accidents that occur within the hospitality facility in this study. This also included the doctor clinic assessments.
2. Accident/Incident investigation reports- this is a more comprehensive document used for each accident logged in the monitoring, this involved interview with the victim, involved parties and their team leader, supervisor, HSE committee representative and manager.
3. Health and Safety committee minutes of the meeting -all raised concerns during the monthly meeting related to the accident occurrences for year 2022 had been checked and verified.

Data Collection

The initial step taken by the researcher to conduct this study was to request through the company through e-mail and was allowed following that the researcher will follow all ethical considerations, particularly company's confidentiality. Afterwards, researcher agreed to the company's request and given the approval to review the records of the work accident monitoring records, accident/incident investigation records and all Health and Safety committee minutes of the meeting. After a week, all data were summarized by the researcher and was presented to the Occupational Safety and Health manager and supervisor to which they agreed to aim an accident reduction of 5% from the previous year and aim the objective of the study. In a span of one month, the root cause analysis for each data were identified and in another two weeks the researcher had created a proposed workplace safety program, this was discussed again to Occupational Safety and Health manager and supervisor and they were able to agree on the safety program, given that Company X already has an approved budget at the beginning of each year due to the requirement under Department of labor and employment (DOLE), thus, the required amount for this study did not become an issue, following all the target completion of each safety program the researcher continued to monitor the result by getting the monthly severity rate thus, at the end of the year were able to fully implement all the Workplace safety program.

Data Analysis

For the analysis and presentation of the study data, they were analyzed with the aid of the following tools:

Severity Rate: The Department of Labor and Employment (DOLE) in the Philippines uses a specific formula to compute the severity rate of workplace injuries. The severity rate is a measure of the seriousness of injuries by calculating the number of lost workdays per 1,000,000 hours worked. In this study this was used as a metric for the company to determine the safety status of Company X; this particularly determines how critical or serious the effects of an injury or illness are. This is computed by number of lost workdays x (number of employee headcount x total working hours per employee) / Total number of hours worked by employees. This helped the researcher to determine the total lost workdays due to workplace injuries.

Control Chart: This tool is used to track process data over time and identify any unusual variations that may indicate problems. In this study, this was utilized by the researcher to monitor the trend of severity rates (likely to refer to workplace accidents or incidents) monthly. The control chart helped in identifying any variations or trends that might indicate issues in the safety processes. If the chart showed that certain controls or measures were exceeding acceptable limits, it signaled the need for further analysis and potential adjustments to prevent future accidents.

Ishikawa Diagram (Cause and Effect Analysis): This method was used to delve into the root causes of

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identified workplace accidents. The causes were categorized into six key areas: equipment, process, people, materials, environment, and management. This categorization helped in systematically analyzing each factor's contribution to the accidents, making it easier to pinpoint specific issues.

Problem Tree Diagram: Stakeholders and program planners utilized the problem tree diagram as a complement to the Ishikawa diagram. This tool helped visualize the positioning of the identified causes from the Ishikawa diagram, and it illustrated the immediate, medium, and long-term safety and health effects of these causes on employees. This method was crucial for strategic planning and for understanding the broader impact of the identified issues.

Logical Framework Analysis (LFA): LFA was applied to the entire process of implementing, monitoring, and evaluating the workplace safety program. It provided a structured approach to planning and managing the program, ensuring that all aspects were thoroughly considered, and that the program's progress could be effectively tracked and assessed.

Hazard Identification and Risk Control (HIRAC): It's a systematic approach used to identify and minimize potential hazards in the workplace. The method was used to conduct a thorough inspection of the workplace to identify any factors that could pose a risk to employees' health and safety and thus was used to assess the level of risk associated with each identified hazard in terms of evaluating the likelihood and severity of the potential harm that could occur. Lastly, use it to implement control measures to eliminate or minimize the identified hazard.

Paired T-test (Dependent T-test): This statistical method was used to compare the severity rates of workplace incidents between the years 2022 and 2023. The paired t-test allowed the researchers to determine if there was a statistically significant difference in the severity rates from one year to the next, which would indicate whether the safety program had an impact.

In summary, these tools and methods were systematically used to analyze workplace safety data, identify root causes of accidents, plan interventions, and assess their effectiveness over time.

Ethical Consideration

The company approved and required the researcher to conform to the ethical conduct of research studies as well as the Data Privacy Act of 2012, thus, all sensitive personal information will not be collected in the process of the review of related records. The company's identity and some geographical characteristics (which can make it distinguishable) will also not be disclosed to protect the privacy and confidentiality of the company to be studied. As much as possible, the proponent will collect data electronically to minimize the generation of written records, which can pose a high risk of being misplaced or lost and would consequently lead to the discovery of any information written in the record.

RESULTS and DISCUSSION

The results of this study are divided into five phases consisting of each step in the DMAIC process of the Lean Six Sigma Methodology, including all the needed tools to complete the definition and assessment of these processes.

1. Define Phase

The information about the project is presented in the project charter below,

Project Name
Workplace Accident Reduction Program for Company X
Business Case

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Since the same areas report with more frequent work-related accidents, there needs to be a concerted effort to improve the work processes in these areas in such a way that work-related accidents will be lessened after this program is implemented.			
Problem/Opportunity:		**Scope, Constraints, Assumptions**	
This program is expected to deliver two (2) periodic training programs, one for increasing awareness of the company's workplace safety and health culture and one for the improved SOPs in the facility areas to be addressed. This program is also expected to deliver the improved SOPs of the targeted facility areas for the training of these SOPs to be realized. This program will not be responsible for any SOP improvements done outside the targeted facility areas, but this program can be expanded in future implementations to include other facility areas depending on the health and safety committee's regular monitoring of workplace accidents.		Once implemented, this program will constitute a substantial part of the workload of the facility's HSE committee, and as such, the resources of this committee will be fully mobilized, and the realization of the program's objectives will be dependent on the performance of this committee overall. It is assumed that the program will be readily approved by the management since there is a need to comply with Zero Accident policies as delineated in the occupational safety and health programs of the Department of Labor and Employment.	
Goal		**Team Members:**	
To decrease the severity of work accidents reported at the food and beverage, culinary, housekeeping, and table games sections by 5% per section per year in two years.		Company X Health, Safety, and Environment Committee	
Preliminary Project Plan	**Target Date**		**Actual Date**
Define	Oct 2022		Oct 2022
Measure	Oct 2022		Oct 2022
Analyze	Nov 2022		Nov 2022
Improve	Dec 2022		Dec 2022
Control	Jan-Dec 2023		Jan-Dec 2023
Prepared by	M. De Guzman	**Approved by:**	Confidential

The hospitality facility to be studied (Company X) is in Pasay, an area in which there are also many other hospitality facilities because one of the international airports of the Philippines is in this area as well. The hospitality facility also houses an area for gaming, which is one of the more well-known amenities of this facility. Figure 2 provides a diagram that summarizes these processes. In this diagram, the suppliers for the facility's hotel, restaurant, and gaming services, as well as its different service providers, are listed in the 'Suppliers' part of the diagram, while the 'Input' part constitutes The hospitality facility to be studied (Company X) is in Pasay, an area in which there are also many other hospitality facilities because one of the international airports of the Philippines is in this area as well. The hospitality facility also houses an area for gaming, which is one of the more well-known amenities of this facility.

As the hazard identification, risk assessment, and control (HIRAC) forms recorded per department show, the facility is divided into three main departments. This section will discuss all these departments in detail, including the work processes observed in these areas. The demonstrated SIPOC diagram verifies that work

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accidents usually happen during the conduct of work processes (Huang et al., 2018).

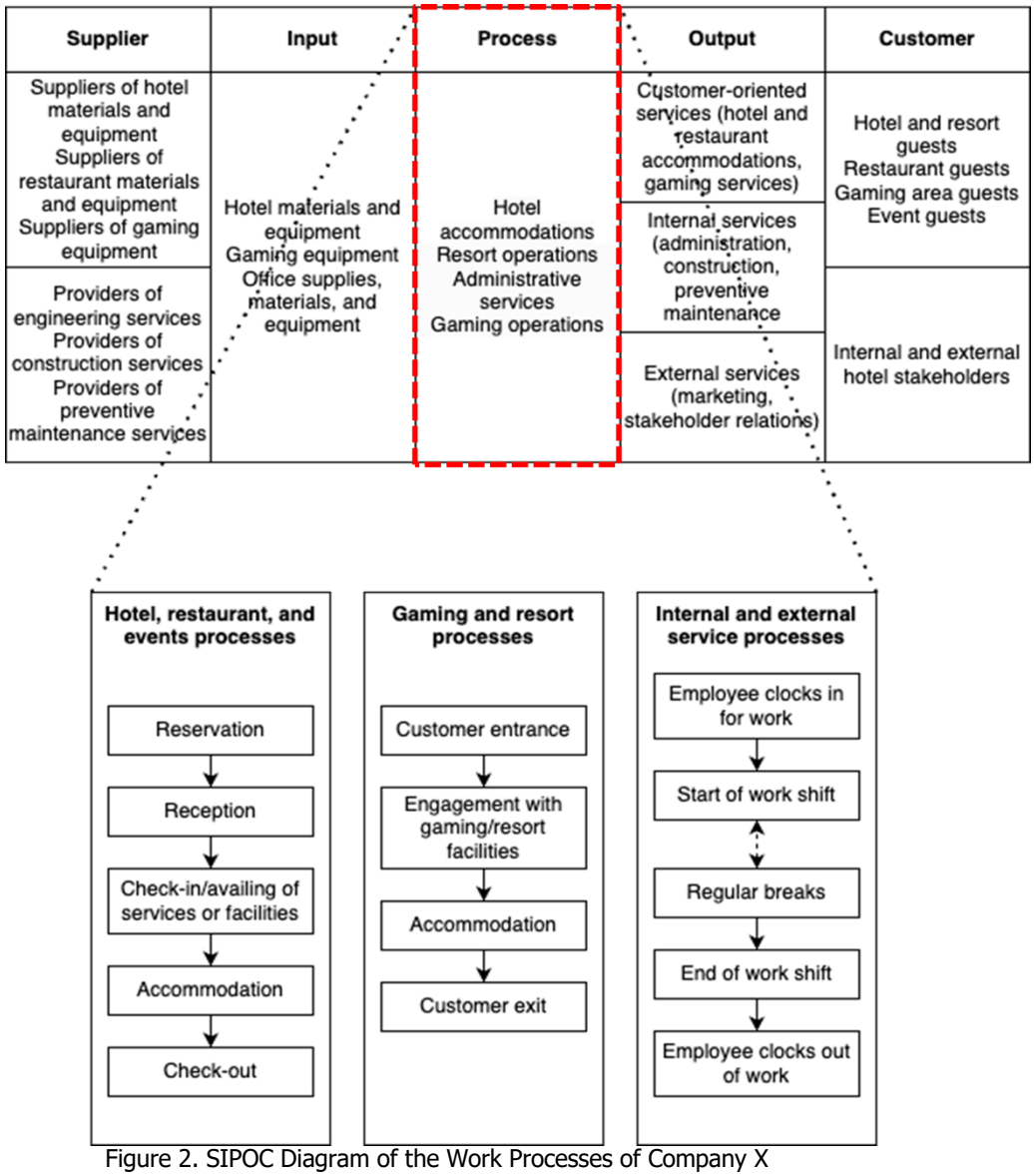

Figure 2. SIPOC Diagram of the Work Processes of Company X

General and Administrative Services Division

This division houses the sections in charge of the general and administrative operations of the facility. The administrative operations that involve HIRAC records include the internal audit, brand and marketing, IT technology, purchasing, surveillance, and finance sections; among these, office work is the most frequently observed work process. The retail office is also part of this division, which mostly conducts office work related to the management and oversight of the facility's retail stores and shops.

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As for the general services, there are receiving areas, which are under the materials management section of this department. These include the various receiving areas connecting to the other general and administrative sections, as well as the receiving office, which oversees the day-to-day receiving activities of the facility. Another linked facility is the warehouse, which is under the materials management section. This floor has the main beverage storeroom, general store, and logistics areas.

A part of the general services also includes housekeeping-related services. The housekeeping section oversees activities that maintain the cleanliness and orderly maintenance of the facility, and with this is the laundry and wardrobe section, which is in charge of the laundry-related work and the receiving and returning of garments, respectively. A 'public area' is also observed in the HIRAC records of the facility. However, upon closer inspection, the processes involved in this area are the cleaning of the facility's floors, carpets, and other external facilities, which may be linked to the facility's housekeeping work. The facility's HIRAC assessment also observes a stewarding section, which spans all kitchen-related operations. These operations are like those listed in references that cite the normal work processes of hotel housekeeping, which can be perceived as sources of potential workplace accidents and consequent injuries (Rosemberg et al., 2019).

There are also various construction areas within the facility that they assess in terms of reporting hazards and assessing risks.

Resort Operations Division

The resort's operations department primarily consists of hotel administration offices, including the duty manager's office, training office, call center and reservations office, guest services, and hotel transportation services. Most office work involves routine tasks like document preparation and handling, but some employees must leave the facility to serve guests, like those in hotel transportation services. The facility also has its main engineering department, with its civil, mechanical, and electrical divisions. These divisions are responsible for civil works and other carpentry works, preventive maintenance tasks, and electrical-related preventive maintenance tasks, respectively.

There is a culinary administration and hygiene section in this department, which is responsible for liaising with the hotel's clientele and stakeholders for promotion of the facility as well as training-related activities for its staff. There are separate HIRAC records observed for each of the facility's amenities, including a spa and swimming pool, VIP and executive lounges, 12 restaurants, in-room dining facilities, and a dining facility for employees. Most of the work processes observed in these areas include food service and handling for the restaurants and dining facilities, while cleaning and maintenance operations are mostly observed for the other amenities.

Gaming Operations Division

Under this division, sections wherein HIRAC records were observed include the areas for the slot machines, table games, cage games, and count games. The work processes observed for these sections mostly include the maintenance of the machines and equipment included in operating these gaming sections, along with areas wherein interaction with computers is required. These areas also have office work, which includes filing, storing, and moving documents.

2. Measure Phase

The company conducted these accident and incident summaries, and the results reported in this section were from the year 2022. The company conducted these accident and incident summaries on a bimonthly basis, and the results reported in this section were the data reported by the facility from the year 2022. Below is the table for the result of the monthly severity rate for the year 2022 and the sigma level under accident lost days per million.

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Table 1. Company X year 2022 monthly severity rate & Accident Lost Days Per Million

MONTH	MONTHLY SEVERITY RATE OF COMPANY X	Accident Lost Days Per Million		
		No. of Days Charged to Accident	No. Of Employees	Sigma Level
JANUARY	0	0	6433	0
FEBRUARY	8	6	6456	4.7
MARCH	2	2	6478	5
APRIL	63	54	6543	3.9
MAY	23	13	6995	4.5
JUNE	34	29	7008	4.2
JULY	25	23	7039	4.3
AUGUST	14	13	7038	4.5
SEPTEMBER	81	71	7058	3.9
OCTOBER	23	15	7097	4.4
NOVEMBER	21	20	7140	4.4
DECEMBER	8	6	7403	4.7

Note: All data captured are from Company X Management Review result for year 2022. The Sigma Level was computed using the website *https://westgard.com/six-sigma-calculators.html* where in the defects observed was equal to total charged days and sample size was the total number of employees of company X.

Table 1 illustrates the situation at the close of 2022. From July to December, the trend continued and left the second half of the year 2022 with a result of a 25.99 severity rate and a total of 868,737 safe man-hours out of 10,686,281 total working hours (8.13%). Still, the same departments had ranked with the highest reported cases. Most accidents and illnesses reported were due to unsafe acts (54%), and the predominant injury types include sprains and strains, burns, superficial injuries, and other wounds. The predominant causes of these accidents and illnesses, meanwhile, are from materials or object handling procedures, handling of hand tools, and handling of work machines and equipment. As for the manner of injury, being struck by moving objects is the most prevalent, followed by falls of persons on the same level, being struck by falling objects during handling, striking against stationary objects, and contact with hot substances. For the year 2022, the severity rate of each month is presented by the below control chart.

In the first biannual report of 2022, more on-site than off-site accident cases were reported, and most on-site accidents were work or facility related. This resulted in a severity rate of 22.01 and a total of 944,247 safe man-hours out of 4,862,842 total working hours (19.42%). The four departments with the highest reported accident cases included food and beverage, housekeeping, culinary, and table games. Most accidents and illnesses reported were due to unsafe acts (70%), and the predominant injury types included superficial injuries, sprains and strains, and other wounds. The predominant causes of these accidents and illnesses were materials handling procedures, handling of hand tools, and handling of work machines and equipment. As for the manner of injury, being struck by moving objects was the most prevalent, followed by falls of persons on the same level, being struck by falling objects during handling, and striking against stationary objects (Lu, 2021; Occupational Safety and Health Standards, 2020).

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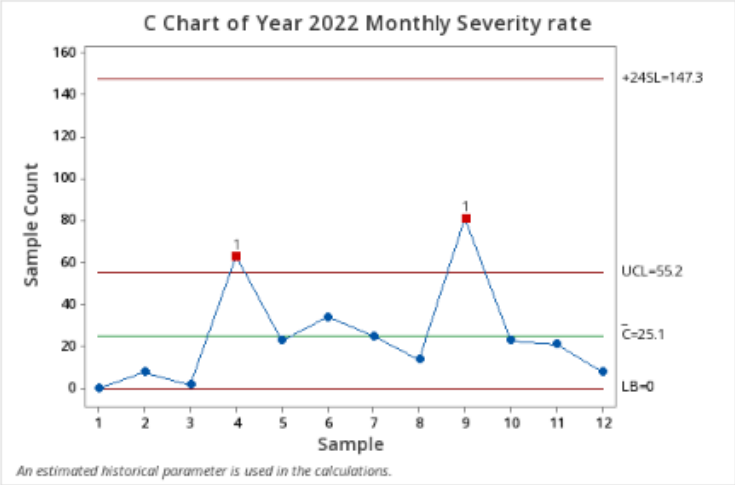

Figure 3. C Chart of year 2022 Monthly Severity rate

The chart in figure 3 indicated that point 4, or the month of April, and point 9, which was the month of September, have failed test points. In the accident lost days per million table, it has a result of 3.3 sigma level for the year 2022. Using the table of six sigma, this interprets a yield of 96.4%.

At this part of the study, the methods involved in planning the program and its objectives and activities (as will be reported in Phases 3 to 5 of the DMAIC roadmap further in this protocol) were already implemented, and the trends that will be explained in the 2023 year-end reports reflect the results of the program as implemented.

3. Analyze Phase

From the periodic reports given by the company in relation to the management of work accidents and illnesses, some general findings are seen regarding areas for potential improvement in the accident and incident management of the company, which include:

1. The same work areas report the most frequent accident cases (food and beverage, culinary, housekeeping, and table games)
2. Causes of injuries predominantly constitute unsafe acts as compared to unsafe conditions; and
3. Falls of people on the same level constitute the prevalent accident type in both reporting years (2022 and 2023)
4. The two failed test points from the control chart presented

Considering these four general findings, root cause analysis can be done to determine the probable causes behind these problems. The DMAIC approach employs two methods in this section: the Ishikawa fishbone diagram and the problem tree analysis. Additionally, the problem tree analysis is employed. The Ishikawa fishbone diagram is recognized as one of the seven fundamental quality tools. (Ishikawa cause & effect diagram | ASQ, n.d.), which enables the identification of as many possible causes for an effect or a problem and can also be used to structure brainstorming sessions to sort ideas into useful categories. On the other hand. Problem tree analysis is an industrial engineering tool that aims to analyze an existing situation by identifying the major problem along with its causal relationship (positioning issues: the problem tree, n.d.). With these two methods of root cause analysis, one can be aware not only of the cause of the problem at hand but also of the possible effects of this identified problem on the workplace.

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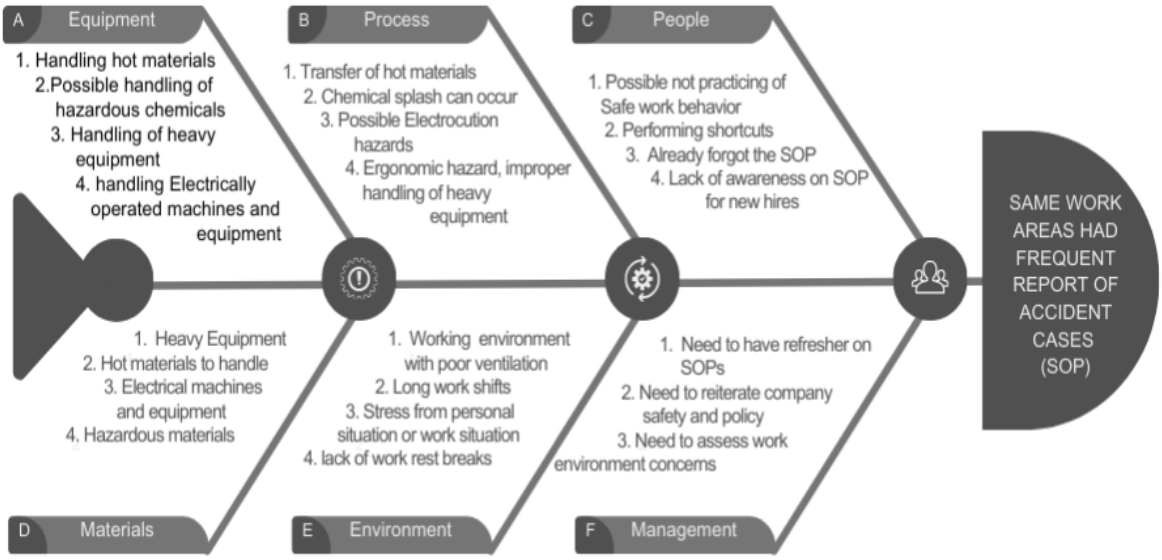

Figure 4. Ishikawa diagram analyzing causes for the identified accident investigation problems

The figure illustrates an Ishikawa diagram outlining the potential causes of the identified issue, specifically, that the same sections reported the most work-related accidents in both years. The diagram categorizes causes into four areas: materials and equipment, processes, environment, and people and management.

In the materials and equipment category, frequent accidents involve handling hot materials (e.g., in food processing), hazardous chemicals (e.g., in housekeeping), and electrical machines (e.g., in gaming areas). The process category covers unsafe interactions with these items. The environment section highlights contributing factors such as poor ventilation, extended shifts, and lack of proper rest breaks.

Under people, behavioral factors like unsafe practices, careless work, and limited awareness of standard procedures are noted. Finally, management causes the need for clearer communication of safety policies, enforcement of standard procedures, and reassessment of accident-prone sections.

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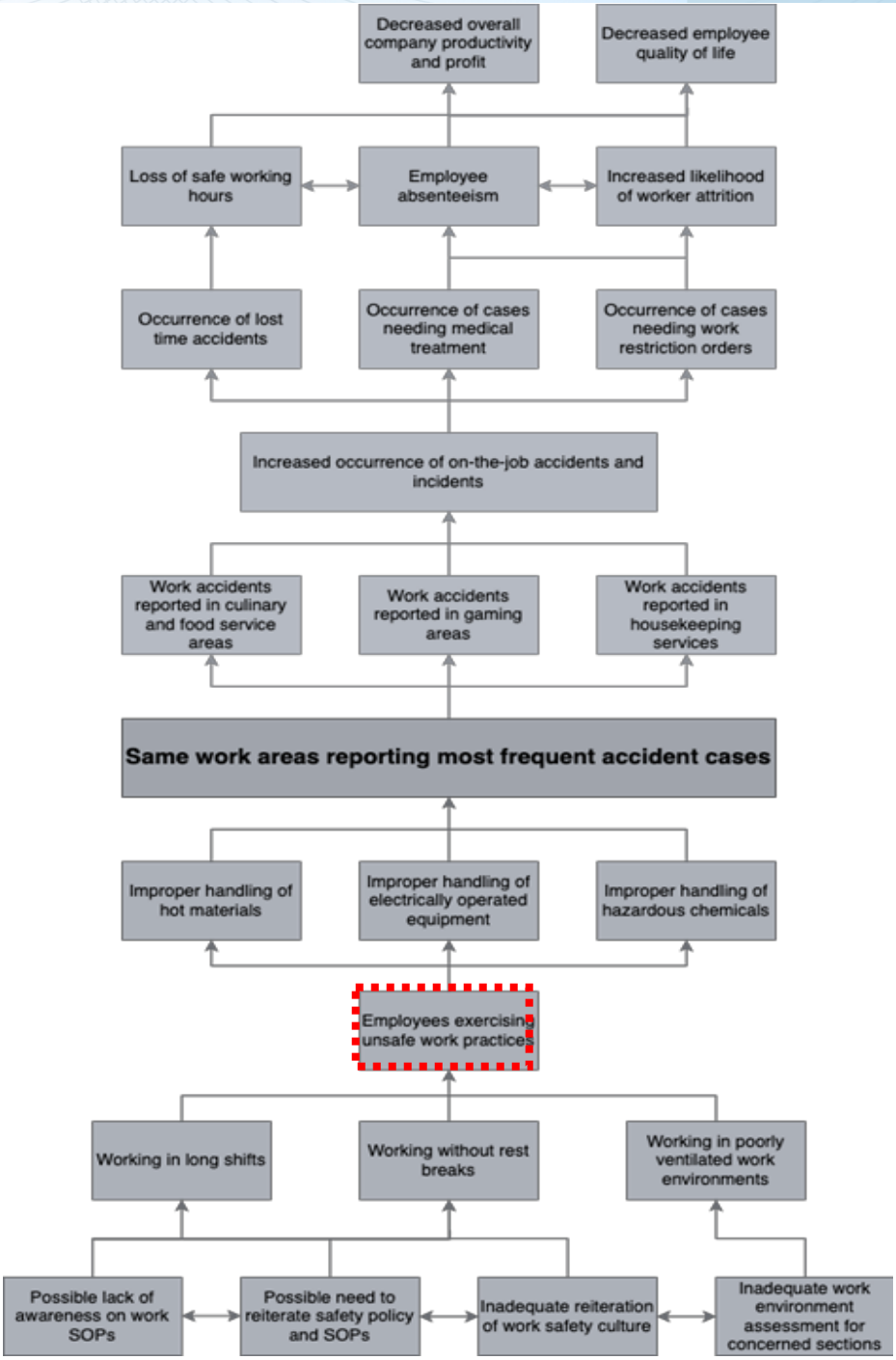

Figure 5. Problem Tree

Figure 5 represents the Ishikawa diagram that delineates the possible causes of the problem identified, which, among the three, would be that the sections most frequently reporting work accidents are the same

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sections for both years. The Ishikawa diagram is dissected into causes related to the materials and equipment, work processes and environmental factors, and the employee and management factors. For the materials and equipment causes, noting the sections reporting these accident concerns, there are certain work procedures aligned at the handling of hot materials (as in those used in cooking and processing food), hazardous chemicals (as may be part of the cleaning agents for housekeeping processes), and electrically operated machines and equipment (as in those used in the gaming areas). The processes that involve the interaction with these materials and equipment are those causes delineated in the 'Process' section of the diagram, and environmental factors that can aggravate the likelihood of accident occurrence, such as the possibility of working in poorly ventilated environments, as well as some employees experiencing working long shifts or working without any proper rest breaks, are those causes that are highlighted in the 'Environment' section. For the "People" part of the diagram, causes identified were mostly behavioral, such as the possibility of not performing safe work practices, haphazard work, and factors concerning the awareness of the company's standard operating procedures. Finally, the "Management" part of the diagram focuses on the possible needs for the management to reiterate to workers regarding the company safety policy, guidelines, safe work procedures, and standard operating procedures, as well as the need to reassess the work environments of the sections that are frequently reported to have work accidents.

Complimentary to the Ishikawa diagram, the problem tree is made for the stakeholders and program planning team to have an idea of where to position the causes identified in the Ishikawa diagram and identify the immediate-to-long-term safety and health effects of these causes to the employees. In this analysis, the root causes were identified to be the possibility of the lack of worker awareness on SOPs, which come in part with the other root causes including the possibility of a need to reiterate the safety policy of the company, its safety culture, and inadequate work environment assessment for the sections which currently report work accidents.

These causes result in workers not complying with these standard operating procedures, such as those working in long shifts and those who do not take rest breaks, while the inadequate work environment assessment leads to the likelihood of workers working in poorly ventilated work environments. These noncompliance measures lead to employees exercising unsafe work practices, including the improper handling of hot materials, electrical equipment, and hazardous chemicals, which are the possible sources of hazards for the sections which currently report with work accidents (Rosemberg et al., 2019).

If left unaddressed, the current trends in work accidents will persist in the mentioned sections, potentially resulting in an increase in on-the-job accidents or illnesses within the company. This is detrimental because the company has worked hard to reduce these incidents over the past few years. An increase in these accidents or illnesses can increase the likelihood of cases needing medical treatment or work restriction, as well as lost-time accidents. These can lead to employee absenteeism, increased worker attrition, and loss of safe working hours, and these three effects can negatively impact not only the quality of life of the employees while at work, but also the company's productivity and profit (Karlsson et al., 2022; Rosemberg et al., 2019).

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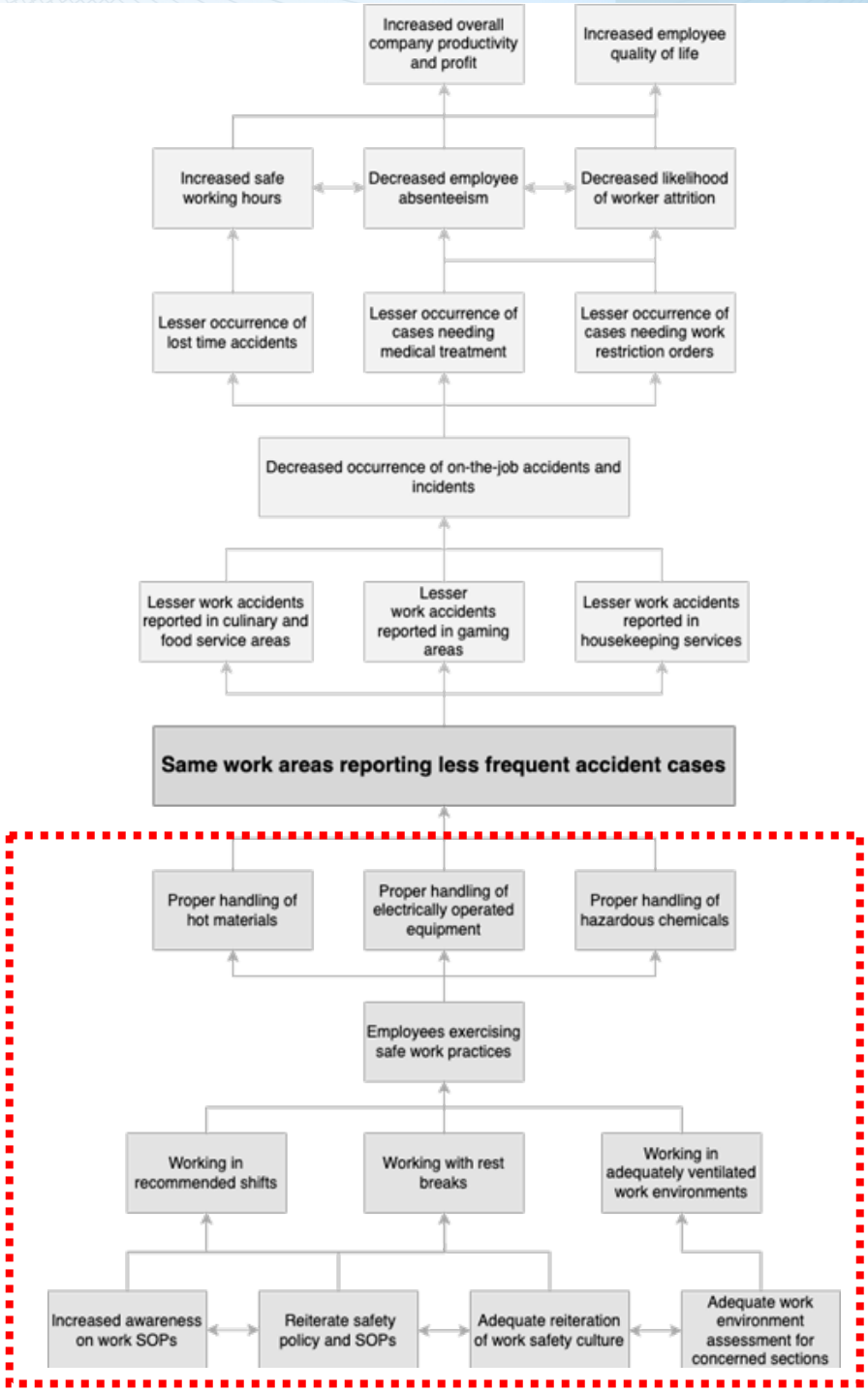

Figure 6. Alternative Tree

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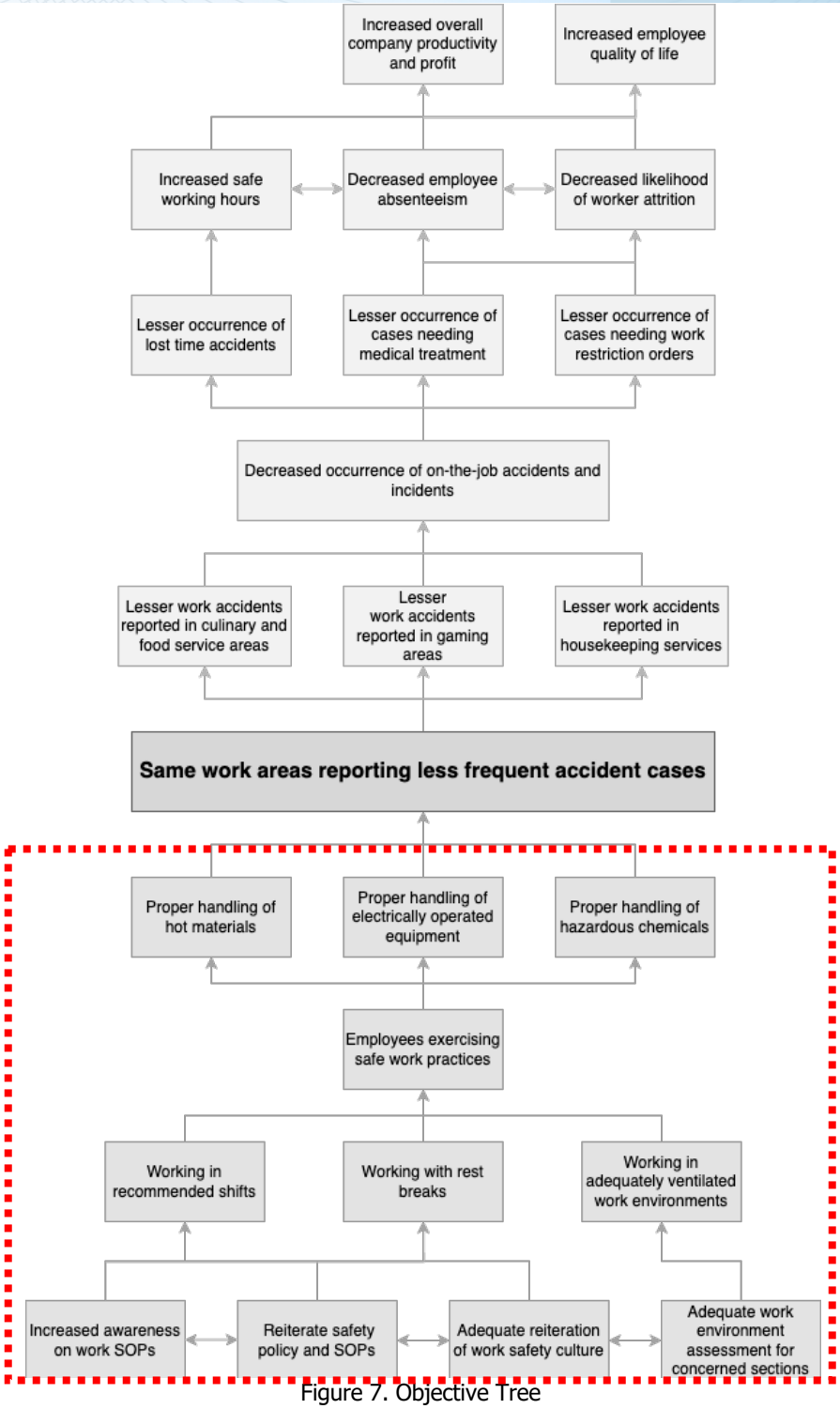

Figure 7. Objective Tree

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Figures 6 and 7 illustrate the alternative tree and objective trees, which are specific variants of the problem tree shown in Figure 5. Specifically, the alternative tree is a reiteration of the problem tree, wherein all the statements in it are translated into positive statements, which will be the template for the objective tree in Figure 7. In Figure 6, the highlighted boxes will now represent the overall objectives of the program to improve accident investigations, which will be conducted in the final phases of the DMAIC analysis.

4. Improvement Phase

In this phase, the improvement of the accident investigation commenced, and the preliminary findings planned in this phase of the Lean Six Sigma methodology come from the objective tree, which is the last figure presented in the previous phase.

From the causes identified to be the specific objectives, improvements in the accident investigation program were made, which focused on the following: (1) reiteration of company safety policies and procedures; (2) reiteration of work safety culture; and (3) ensuring adequate workplace environment assessment for the sections that frequently report work accidents. In this phase, the program planning approach of the logical framework analysis can be implemented, since this method of analysis can offer tools for the implementation, monitoring, and evaluation of any program (Mostafavi et al., 2020). Specifically, in this part of the DMAIC process, the LFA step was conducted as part of the analysis strategy, which entailed the development of a workplace safety program plan with component objectives and a specific work plan for every activity that would need to be done under each component objective. In this phase, the program plan and component objectives would be presented following the previous discussion, while the final phase had included the work plans for the implementation, monitoring, and evaluation of activities per program objective, as defined in sources that discuss this approach (Russo & Rindone, 2023). A program plan for accident investigation were conducted for Company X.

Table 2. Company X year 2023 monthly severity rate & Accident Lost Days Per Million

MONTH	MONTHLY SEVERITY RATE OF COMPANY X	Accident Lost Days Per Million		
		No. of Days Charged to Accident	No. Of Employees	Sigma Level
JANUARY	0	4	6944	4.8
FEBRUARY	4	9	6945	4.6
MARCH	15	15	6978	4.4
APRIL	12	27	6970	4.2
MAY	2	2	6998	5
JUNE	10	10	7008	4.5
JULY	8	23	7030	4.3
AUGUST	4	21	7058	4.3
SEPTEMBER	5	9	7058	4.6
OCTOBER	0	0	7097	0
NOVEMBER	5	5	7140	4.7
DECEMBER	0	0	7403	0

Note: All data captured are from Company X Management Review result for year 2023. The Sigma Level was computed using the website *https://westgard.com/six-sigma-calculators.html* where in the defects observed was equal to total charged days and sample size is the total number of employees of company X.

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In Table 2. Company X year 2023 represents the monthly severity rate of Company X. In addition, the accident lost Days per million, the table has a result of 3.7 sigma level for the year 2023. By using the table of six sigma, this interprets a yield of 98.6%. In comparison, you would see in below Table 4 the comparison of the severity rate of Company X for the years 2022 and 2023. Which clearly shows that the drastic difference between each month

Table 3. Company X year 2022 vs year 2023 monthly severity rate

MONTH	Year 2022 MONTHLY SEVERITY RATE OF COMPANY X	Year 20223 MONTHLY SEVERITY RATE OF COMPANY X	COMPARISON
JANUARY	0	4	↑
FEBRUARY	8	9	↑
MARCH	2	15	↓
APRIL	63	27	↓
MAY	23	2	↓
JUNE	34	10	↓
JULY	25	23	↓
AUGUST	14	21	↑
SEPTEMBER	81	9	↓
OCTOBER	23	0	↓
NOVEMBER	21	5	↓
DECEMBER	8	0	↓

The comparison of severity rate for year 2022 and year 2023 marks a total of nine (9) months with decreased value, the overall monthly severity rate for year 2022 was 25.99 while year 2023 was 10.05

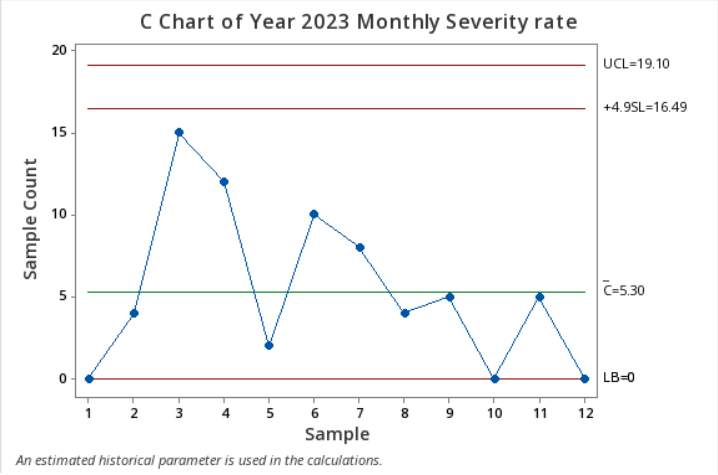

Figure 8. C Chart Company X year 2023 monthly severity rate

The presented chart in figure 8 indicates that there were no failed test points for the year 2023. These findings were also subjected to a t-test, and the result is seen below.

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Table 4. Paired T-Test Descriptive Statistics

MONTH	N	Mean	Standard Deviation	SE Mean
Year 2022 Monthly Severity Rate	0	25.17	24.38	7.04
Year 2023 Monthly Severity Rate	8	5.42	4.93	1.42

Table 5. Paired T-Test Estimation Paired Difference

Mean	Standard Deviation	SE Mean	95% CI for μ difference
19.75	23.62	6.82	24.38

Note: μ difference population mean of (year 2022 monthly Severity rate-year 2023 monthly severity rate)

The null hypothesis is Ho: μ_difference = 0, and the alternative hypothesis is H1: μ_difference ≠ 0. The T-value result is 2.90, while the P-value result is 0.015. The t-test results show that there is a statistically significant difference between the 2022 and 2023 severity rates, resulting in a P-value that is not equal to and less than 0.05.

Overall, from 25.99% in 2022 to 10.05% in 2023, the severity of work accidents at the targeted sections decreased by 15.95%. This demonstration applies the Lean Six Sigma methodology for work accident reduction, wherein a decrease in accident severity rate was noted (Chen, 2015; DiPietro & Condly, 2007; Uluskan, 2022).

The DMAIC steps of the Lean Six Sigma methodology, coupled with the conceptual framework proposed in this study, led to the adequate identification of common trends in the reporting for workplace accidents and incidents in Company X and aided in the identification of areas for improvement and the strategies needed to implement, monitor, and evaluate these improvements. This part of the study discusses the study results, which illustrate the outputs of the DMAIC process, along with its similarities in published literature.

This study was able to show how the DMAIC process as part of the Lean Six Sigma methodology helped in identifying work process problems, the conditions underlying these problems, and the strategies that can be taken to control these problems. While this study applied Lean Six Sigma for OSH in the hospitality industry, some literature sources point out that this method is also seen to be implemented in other workplaces as well.

Mousavi et al. (2021) conducted a study that demonstrates the application of the DMAIC cycle in a hospital setting. The study, employing a quasi-experimental method, employed a total number of 45 operating room nurses for the assessment of safety hazards in the operating room. After applying the Lean Six Sigma methodology in their hospital, the frequency of exposure to chemical hazards had significantly reduced. The mean number of exposures to irritating chemicals and total chemical hazards after the intervention was also significantly reduced.

Another study showed the benefits of the Six Sigma methodology in a diesel engine industry in Europe (Simsek & Turhan, n.d.). Specifically, applying the methodology led to a significant reduction in workplace accidents and injuries at this facility, which has notably experienced nearly the same number of accidents and incidents as those observed in the hospitality industry according to this study's results.

The demonstration of these real-world examples justifies the application of the Lean Six Sigma methodology in the improvement of accident investigation in Company X, as both studies that used this method recommended its application not only to their workplaces but to other industries also. It now falls on the OSH management of Company X to prove the continued effectiveness of the Lean Six Sigma methodology through achieving the program objectives in future assessments.

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The proponent believes that the only limitation on this study is the time constraint, which prevents them from following up on the program's effectiveness over time. This follow-up would have provided insight into Lean Six Sigma's ability to solve the facility's issues with the same departments and sections reporting the most frequent accidents.

5. Control Phase

As the last step in the DMAIC process, all specific activities mentioned in the project charter & workplace program that must be maintained to continuously achieve the objectives of the workplace accident reduction program defined in Phase 4, this means it includes the monitoring and yearly evaluation of the plan; it must be visited yearly, and the company must create necessary additional improvements as needed. Each program will be included in the budget allocation and key performance indicator of the HSE team of Company X to ensure a continuous cycle of implementation.

The c-chart should also be utilized to monitor monthly to verify the trend of the accidents in Company X; this will help in mitigating increases in accident rates whenever there is an occurrence of failed points during the monitoring phase of all accidents at Company X. Therefore, in between, they could create additional revisions in the safety program.

Wherein HIRAC matrices for Likelihood, Impact Scoring, and safety risk were created and, A Hazard Risk Assessment and Control (HIRAC) tool per department was conducted, established and communicated to all departments.

Conclusions

This study successfully achieved its objectives by investigating the effectiveness of the Lean Six Sigma methodology in reducing workplace accidents within a selected hospitality facility in Pasay City. The research provided a comprehensive assessment of existing safety conditions, identified critical risk factors, and measured the severity of work-related incidents in Company X. Through the collection and analysis of relevant data, the study presented a clear understanding of the challenges faced by the facility and the extent of occupational injuries.

Root cause analysis, guided by severity metrics, revealed the underlying contributors to recurring accidents. This data-driven approach supported the development and implementation of a targeted intervention program based on Lean Six Sigma principles. The program led to measurable improvements in both working conditions and safety outcomes. A notable decrease in the severity rate from 2022 to 2023 underscored the effectiveness of the initiative in reducing workplace accidents and fostering a safer environment.

Overall, the application of Lean Six Sigma not only accomplished the goal of minimizing incidents but also introduced a structured framework for continuous improvement in occupational safety and health (OSH) practices in the hospitality industry.

Recommendations

Building on these findings, future research is encouraged to conduct a follow-up assessment in Company X to evaluate the long-term impact and sustainability of the implemented safety program. This would further validate the DMAIC approach as a valuable tool in OSH applications. Researchers may also explore additional diagnostic and planning tools beyond the Ishikawa diagram, problem tree, and logical framework analysis, depending on their expertise and preference.

Finally, it is recommended that the Lean Six Sigma methodology be applied to a larger sample of hospitality facilities across the country. Doing so would not only help validate the effectiveness of this approach in diverse settings but also uncover unique safety challenges within the industry, contributing to broader, data-informed improvements in workplace safety nationwide.

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