



**COLLEGE OF ENGINEERING, DESIGN, ART, AND
TECHNOLOGY
SCHOOL OF ENGINEERING
DEPARTMENT OF MECHANICAL ENGINEERING**

**ASSESSING THE HEALTH, SAFETY AND ENVIRONMENT OF ROADSIDE
FABRICATION WORKSHOPS TO THE NEIGHBORHOODS**

BY

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
**A REPORT SUBMITTED TO THE DEPARTMENT OF MECHANICAL ENGINEERING,
MAKERERE UNIVERSITY IN PARTIAL FULFILLMENT OF THE REQUIREMENTS FOR
THE AWARD OF A DEGREE OF BACHELOR OF SCIENCE IN MECHANICAL
ENGINEERING**

MAY 2025

DECLARATION

I hereby declare that this project report for my final year project entitled, "*assessing the health, safety and environment of roadside fabrication workshops to the neighborhoods*" is original and has never been submitted or published before by another person or organization.

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APPROVAL

This project report has been submitted with our approval as supervisors.

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ACRONYMS

MFWs	Metal Fabrication Workshops
PTEs	Potentially Toxic Elements
UV	Ultra Violet Light
HSE	Health, Safety, and Environment
WHO	World Health Organization
PM	Particulate Matter
VOCs	Volatile Organic Compounds
PPE	Personal Protective Equipment
RSFWs	Roadside Fabrication Workshops

ABSTRACT

This study investigated the health, safety, and environmental impacts of roadside fabrication workshops on surrounding neighborhoods. Roadside fabrication workshops are common in many urban areas, providing essential services but also potentially generating hazards. This research aimed to assess these impacts to inform strategies for mitigating negative consequences and promoting safer, healthier coexistence in Kampala, Uganda. A quantitative research design was adopted, and data were collected through structured questionnaires administered to 40 respondents living at varying distances from RSFWs along Katwe Road, Kampala. The data were analyzed using Smart-PLS SEM to evaluate the relationships among environmental impacts, health hazards, safety hazards, and community perception and engagement. The results revealed that safety hazards such as fire risks, electrical faults, and unstable structures had a strong and statistically significant influence on community engagement ($\beta = 0.585$, $p = 0.004$). In contrast, health hazards ($\beta = 0.107$, $p = 0.561$) and environmental impacts ($\beta = 0.089$, $p = 0.487$) showed weaker and statistically non-significant effects. These findings indicated that communities were more responsive to immediate and visible safety risks than to less tangible health or environmental concerns. The study concluded that addressing safety issues should be a priority in regulatory efforts and recommended the implementation of strict safety and environmental standards, public awareness campaigns, and infrastructure improvements to promote sustainable and safer workshop operations in urban settings.

CHAPTER ONE: INTRODUCTION

1.1 Introduction

This chapter provides the background, problem statement, objectives, scope, and justification of the study, emphasizing the significance of health, safety, and environmental considerations of roadside fabrication workshops and their impact on nearby communities.

1.2 Background

Fabrication workshops are vital to urban and peri-urban economies, offering services like metalworking, welding, and carpentry at affordable costs, thereby fostering job creation, skills development, and support for other sectors (Lehmann, 2018). Particularly in developing regions, they bridge gaps in accessibility and affordability, contributing to local infrastructure development and economic resilience (Muhire, 2017). For example, metal fabrication workshops (MFWs) in Uganda produce construction materials and fabricate industrial and agricultural machines, though their activities often release potentially toxic elements (PTEs) into the environment (Nalugya et al., 2022). Materials used, such as alloyed steel, contain elements like manganese, nickel, and cadmium, known to induce toxic effects depending on their concentration and exposure routes.

The shift of these workshops from industrial areas to roadside locations stems from their proximity to customers, cost efficiency, and reduced regulatory scrutiny, enhancing visibility and operational flexibility. However, roadside workshops pose health, safety, and environmental risks. Workers often face hazardous exposures, such as welding fumes and UV light, without adequate protective measures, leading to respiratory and other health issues (Nuwamanya et al., 2024).

Safety concerns are prevalent, with common hazards including slips, trips, falls, and accidents involving machinery and tools. The absence of safety protocols and proper training increases the likelihood of injuries, which can range from minor cuts and burns to severe fractures and amputations. Moreover, the safety risks extend beyond the workers to the surrounding community; the improper handling and storage of flammable materials and hazardous chemicals can lead to fires, explosions, and other dangerous incidents (Thompson, 2021).

Environmental challenges include waste generation, such as metal shavings and chemical residues, which can contaminate soil and water, harming ecosystems and public health. Noise pollution from machinery disrupts nearby residents, and contaminants from workshop activities degrade soil and

pollute water bodies, causing long-term ecological damage (Bala & Verma, 2020). These implications highlight the need for sustainable practices in roadside fabrication workshops.

1.3 Problem statement

The relocation of fabrication workshops from industrial areas to roadsides in Uganda has caused problems for nearby communities. Residents are exposed to harmful fumes, bright welding lights, and loud noise, which can harm their health and disrupt their daily lives. Poor handling of waste and possible contamination of soil and water add to the environmental risks. With fewer regulations in place, many workshops neglect safety and environmental rules, making the situation worse for people and the environment.

1.4 Objectives

1.4.1 Main objective

To assess the environmental factors of roadside fabrication workshops on nearby neighborhoods.

1.4.2 Specific objectives

- a) To examine the environment in the vicinity of roadside fabrication workshops
- b) To determine roadside fabrication workshops on the health of the neighborhood community
- c) To determine safety hazards posed by roadside fabrication workshops to the nearby neighborhoods

1.5 Scope

This study was to examine the health and environmental impacts of RSFWs along Katwe Road, Kampala, focusing on noise, UV light, chemicals, waste disposal, and emissions. It assessed safety protocols, regulatory compliance, and community concerns to develop HSE recommendations. Therefore, promoting a healthier and safer environment for all. The study was done in a span of nine months during the semesters from August 2024 to April 2025.

1.6 Justification

The shift of fabrication workshops from industrial zones to roadside areas in Uganda creates serious problems for nearby communities. Harmful emissions, ultraviolet light, and pollutants put people's health at risk, especially children and the elderly, causing issues like breathing problems and even long-term diseases. Loud machinery disrupts daily life, raising stress and lowering quality of life. Poor waste management harms soil and water, risking contamination. With weak

regulations, many workshops ignore safety and environmental rules. To solve this, stronger rules and community involvement are needed to protect health, the environment, and livelihoods.

1.7 Significance

At the end of this study, the significance will lie in its potential to improve community health by reducing exposure to hazardous materials and pollutants, thereby lowering the incidence of respiratory issues and other health problems. It aims to protect the environment through better waste management and compliance with regulations, safeguarding local soil and water resources. By mitigating noise pollution, the project enhances residents' quality of life and mental well-being. Additionally, it promotes economic sustainability by advocating for responsible practices within the fabrication industry, fosters community empowerment through active engagement in decisionmaking, raises awareness about health and environmental impacts, and encourages collaboration among stakeholders, ultimately contributing to a healthier and more sustainable future for the community.

CHAPTER TWO: LITERATURE REVIEW

2.1 Introduction

This literature review synthesizes existing research on the implications of roadside fabrication workshops, with a focus on health outcomes, safety hazards, and environmental assessments. It presents; HSE assessments, air pollution, noise pollution, chemical exposure, sanitation and hygiene, fire risks, electrical hazards, structural integrity, traffic hazards, soil contamination, water pollution, air quality degradation, noise pollution, visual pollution, community perception and engagement.

2.2 HSE assessments

Health, Safety, and Environmental (HSE) assessments are systematic evaluations aimed at identifying, analyzing, and mitigating risks to people, property, and the environment. These assessments ensure that workplace practices comply with safety regulations and promote sustainable and safe operations.

2.2.1 HSE measures for fabrication workshops

According to Health and Executive (2007), the following HSE measures should be implemented in fabrication workshops to significantly enhance workplace safety, protect worker health, and minimize environmental impact.

a) Health measures

Proper ventilation is essential in fabrication workshops to ensure a constant supply of fresh, uncontaminated air while effectively removing dust, fumes, and vapors generated during processes like welding, grinding, and painting. Mechanical ventilation systems may be required and should be regularly maintained. Temperature control is also crucial, with provisions made to manage both heat and cold stress through insulation, air movement, humidity control, and appropriate clothing or cooling systems. Adequate lighting must be provided throughout the workshop, especially at workstations and high-risk areas, with emergency lighting available in case of power failure. Maintaining cleanliness across all surfaces and implementing effective waste management systems ensures a hygienic and safe work environment. Workshops must also provide sufficient space for safe movement and operation of machinery, and workstations should be ergonomically designed to reduce strain. Where seated work is possible, suitable chairs and footrests should be provided, and emergency egress must be unobstructed.

b) Safety Measures

All workplace equipment, including welding machines, lifting tools, and ventilation systems, must be routinely inspected and maintained. The condition of the building should also be monitored for structural integrity. Safe and clearly marked traffic routes must be established for both pedestrians and vehicles, with barriers or markings to separate shared paths. Traffic management plans should be in place to limit reversing and enforce speed limits, while surfaces should be stable, unobstructed, and kept free of hazards like oil spills or metal shavings. Staircases and elevated areas must have secure guardrails and handrails, and ladders should not be used as permanent access points. Hazardous areas such as pits or tanks should be fenced or covered to prevent falls. Doors and gates on main routes must include safety features like viewing panels and emergency stop mechanisms for power-operated types. Fire safety is another critical area, requiring the installation and maintenance of alarms, extinguishers, and clear emergency exits, along with regular fire drills. Workers must be provided with appropriate personal protective equipment (PPE), and all hazardous substances should be safely labeled, stored, ventilated, and handled with proper training.

c) Environmental Measures

To reduce the environmental impact, workshops should adopt waste minimization strategies, such as efficient material usage and reuse of resources. Waste segregation and recycling systems should be implemented with clearly labeled containers for different waste types. Proper management of hazardous waste, such as used oils and paints, includes safe storage, labeling, and disposal through licensed handlers. Air emissions from fabrication processes should be controlled using fume extractors and dust collectors, which must be regularly maintained. Noise emissions should be mitigated with dampening materials and equipment isolation, while hearing protection should be provided. Energy conservation can be achieved through the use of energy-efficient lighting and optimized HVAC systems, and renewable energy sources like solar panels should be considered. Water conservation efforts may include leak repairs, efficient equipment, and recycling systems, while wastewater should be treated before disposal. The use of sustainable materials and designing products for material efficiency can further reduce environmental impact. These practices should be guided by a comprehensive environmental policy, with continuous monitoring of performance indicators such as emissions and waste levels. Environmental training should also be provided to ensure workers understand and follow best practices.

2.2.2 Methods of HSE assessments

The following are the methods of HSE Assessments;

- a) Risk assessment: Identifying hazards, evaluating risks, and determining appropriate controls to reduce risks to acceptable levels.
- b) Hazard identification: A process to detect potential hazards in operations or processes.
- c) Job safety analysis: Breaking down tasks to identify risks associated with specific jobs and implementing safeguards.
- d) Evaluating potential environmental harm and proposing measures to minimize impact.
- e) Audit and inspection: Regular checks to ensure compliance with HSE standards and practices.

2.3 Health hazards of roadside fabrication workshops

Health: This defines in the preamble of the constitution of the World Health Organization (WHO) as a state of complete physical, mental and social wellbeing and not merely the absence of disease or infirmity. Health hazards will be assessed in terms of air pollution, noise pollution, chemical exposure, and physical hazards as explained in the following sub sections.

2.3.1 Air pollution

Air pollution in roadside fabrication workshops primarily results from the release of particulate matter (PM) and harmful gases during welding, grinding, and painting activities. Welding, in particular, produces fumes containing metals such as manganese, chromium, and nickel, which are known respiratory irritants and can lead to serious health conditions like metal fume fever, chronic bronchitis, and lung cancer in long-term exposures (Antonini, 2003). Grinding operations release fine metal particles into the air, which, when inhaled, can cause respiratory issues and potentially toxic metal accumulation in the body. Painting activities further contribute to air pollution through the emission of volatile organic compounds (VOCs), including toluene and xylene. These VOCs are not only irritating to the respiratory tract but they are also recognized neurotoxins and carcinogens (Kathleen et al., 2001). Communities near such workshops, the cumulative effect of these emissions may lead to increased incidences of respiratory problems, particularly among vulnerable populations such as children and the elderly.

2.3.2 Noise pollution

Noise pollution from machinery used in roadside fabrication workshops such as compressors, grinders, and welding machines, is a significant concern. High noise levels in such settings often exceed the recommended safety thresholds set by occupational health agencies, therefore, causing hearing loss and stress-related health issues among workers and nearby residents. Chronic exposure to high noise levels has been associated with an increased risk of cardiovascular disease, cognitive impairment, and sleep disturbances, particularly in children who are especially sensitive to auditory disturbances (Basner & Babisch, 2014). For the surrounding neighborhood, this type of noise pollution can disrupt daily activities.

2.3.3 Chemical exposure

Chemical exposure is prevalent in roadside workshops due to the frequent use of solvents, paints, and cleaning agents containing hazardous compounds like benzene, methanol, and lead-based additives. Workers and nearby residents may be exposed to these substances through direct contact, inhalation, or accidental ingestion. According to WHO (2020), Chronic exposure to benzene and other volatile chemicals can lead to severe health issues, including neurotoxicity, liver and kidney damage, and carcinogenic effects, especially when adequate protective measures are lacking . A Study by Grandjean and Bellanger (2017) showed that communities in close proximity to workshops using such chemicals experience higher incidences of chemical-related ailments, reinforcing the need for strict control and safety measures.

2.3.4 Sanitation and hygiene

Sanitation and hygiene challenges are a major issue in roadside workshops, where waste management is often poorly implemented. Waste materials including metal shavings, used oil, and chemical containers, are often improperly disposed-off, leading to environmental contamination. According to Pathberiya et al.(2017), poor sanitation infrastructure, such as inadequate toilet facilities, exacerbates the health risks, as unhygienic conditions can foster the spread of infectious diseases and create a breeding ground for pests. Improper disposal of hazardous waste also affects nearby communities, as it can contaminate soil and water sources, exposing residents to heavy metals and toxins.

2.4 Safety impacts of roadside fabrication workshops

Safety: is a property of a system that will not endanger human life, the environment and property (Slater, 2013). This is typically analyzed in two forms, hazard analysis and risk analysis. Hazard analysis is the examination of a system for potential to cause harm. In it the system or a model of the system is examined for ways in which it can cause harm or dangerous situations. Risk analysis examines the potential damage that can result from the hazards present in a system. This study is going to evaluate safety impacts in terms of fire risks, electrical hazards, structural integrity and traffic hazards as explained in the following sub sections.

2.4.1 Fire risks

Fire hazards are a significant safety concern in roadside fabrication workshops due to the routine use of flammable materials like solvents, paints, and fuel, alongside high-risk activities such as welding and metal cutting. These activities produce sparks and, in some cases, open flames that can easily ignite surrounding combustible materials if not properly managed. A study by Afrin et al., (2023) showed that inadequate storage and handling of flammable substances greatly heightens the risk of fire, particularly in environments with limited safety protocols. For nearby neighborhoods, the lack of fire containment measures and fire suppression systems in many informal workshops presents a direct threat, as fire originating in a workshop can quickly spread to adjacent buildings, especially in densely populated areas.

2.4.2 Electrical hazards

Electrical hazards are prevalent in roadside workshops, where makeshift wiring and overloaded circuits are commonly used to power heavy machinery and tools. Research highlights that poorly designed electrical setups increase the risk of shocks, short circuits, and fires due to inadequate grounding, lack of insulation, and overloaded electrical systems (Yasemin et al., 2009). In roadside workshops, where safety inspections are often overlooked, the probability of electrical incidents is high, endangering both workers and nearby residents. For the surrounding neighborhood, these electrical risks extend beyond the workshop, as fires triggered by electrical faults can rapidly spread to adjacent buildings, exacerbating safety hazards in areas with limited emergency response resources.

2.4.3 Structural integrity

Structural integrity is a major issue in roadside workshops, which are frequently constructed with temporary materials and without adherence to building codes. These makeshift structures often degrade over time and lack the stability needed to support heavy equipment or withstand extreme weather, making them prone to partial or full collapse. The risk of structural failure is amplified in workshops situated in densely populated areas, where falling debris or collapsing structures pose a serious hazard to both workers and residents (Kumar et al., 2019).

2.4.4 Traffic hazards

Traffic-related hazards are a common issue for roadside workshops that operate adjacent to busy streets, where lack of clear signage and protective barriers increases the risk of accidents. Workshops located close to roads pose a risk to both workers and passersby, as drivers may not anticipate the presence of pedestrians or equipment spilling into traffic lanes, especially in highspeed or congested areas (Islam et al., 2018).

2.5 Environmental impacts of roadside fabrication workshops

The term ‘environment’ is complex and conveys different meanings: the word ‘environment’ is employed as a synonym for space, territory, place, or ecosystem. A comprehensive definition of environment describes it as the set of conditions in which living takes place: it is the complex system of physical, chemical and biological factors, of living and non-living elements and of the relationships in which all the organisms that inhabit the planet are immersed (Buongiorno & Chiamonte, 2023). This study is going to examine the environmental impacts in terms of soil contamination, water pollution, air quality degradation and visual pollution, as explained in the following sub sections.

2.5.1 Soil contamination

Soil contamination around roadside fabrication workshops is a common environmental concern due to the frequent spills of chemicals such as oils, solvents, and paints, as well as improper disposal of metal shavings and waste. According to Tuu (2023), workshops often lack appropriate waste management systems, leading to the accumulation of hazardous materials in the soil, which can have harmful effects on local ecosystems and human health. Heavy metals like lead, cadmium, and chromium are commonly found in the soils surrounding such workshops and can persist for long periods, posing risks of bioaccumulation and potentially affecting local vegetation and food

chains (Kachenko & Singh, 2006). For communities near these workshops, soil contamination increases the risk of exposure to toxic compounds, which can lead to health issues such as skin irritation and, over time, chronic conditions including cancer and organ damage.

2.5.2 Water pollution

Water pollution is another significant environmental impact linked to roadside workshops, primarily due to chemical runoff and washing activities. Many workshops wash equipment and dispose wastewater directly onto the ground, allowing contaminants to leach into nearby water sources. A research by Bhattarai and Conway (2021) revealed that runoff from these activities often contains hazardous materials, including heavy metals, oils, and other toxic chemicals that can infiltrate groundwater or flow into rivers and streams, affecting water quality and aquatic ecosystems. The resulting water pollution can harm local flora and fauna, disrupting aquatic life and rendering water unsafe for human consumption. Communities relying on groundwater or local water bodies for drinking, agriculture, or recreation face a heightened risk of exposure to these pollutants, which can lead to various health problems such as gastrointestinal issues and heavy metal poisoning (Cao et al., 2010).

2.5.3 Air quality degradation

Air quality degradation is a notable issue near roadside fabrication workshops due to the emissions of particulate matter (PM), volatile organic compounds (VOCs), and fumes from welding, grinding, and painting activities. Dust from grinding and cutting operations can also settle in the surrounding area, reducing air quality and increasing respiratory issues among nearby residents (Upadhyay, 2023). For vulnerable populations, such as children and the elderly, exposure to these pollutants poses additional health risks, including asthma, bronchitis, and other chronic respiratory conditions.

2.5.4 Visual pollution

Visual pollution from poorly maintained workshops and scattered debris is a significant environmental concern that impacts both aesthetics and the well-being of nearby residents. According to Abubakar et al. (2022), his research revealed that unkempt surroundings, including litter, abandoned materials, and visible waste, contribute to a sense of environmental degradation. Scattered debris and haphazardly stored materials do not only detract from the visual appeal of the neighborhood but may also serve as breeding grounds for pests, compounding public health

concerns. Furthermore, the presence of unmanaged waste and visually cluttered spaces can reduce property values and contribute to a perception of neglect, potentially affecting community morale and engagement in environmental stewardship (Carson, 2022).

2.6 Community perception and engagement

Although much had been written about the occupational Health Safety Environment (OHSE) issues in Uganda, there are no publications on the health, safety and environment of roadside fabrication workshops to the neighborhoods.

2.6.1 Community awareness and perceived health risks

Evaluating how much the community knows about the health risks posed by roadside fabrication workshops is crucial. This includes understanding residents' concerns about respiratory issues, noise pollution, and other health impacts from pollutants generated by these workshops. Nkuh et al.(2023), in his study found out that residents often feel powerless against these health and safety threats, which can drive them to mobilize for regulatory changes.

2.6.2 Environmental impact and localized concerns

Assessing the environmental degradation around roadside workshops, such as pollution in air and water quality, waste management practices, and potential contamination, provides insight into community concerns over environmental harm. According to Bullard and Johnson (2000), community-led efforts have previously shown success in advocating for better health, safety, and environmental standards, indicating that such grassroots mobilizations can significantly influence policy.

2.6.3 Community engagement and advocacy through digital platforms

The use of social media and other digital tools has been instrumental in raising awareness and mobilizing public opinion on health, safety, and environmental issues related to roadside fabrication workshops. According to Djalante and Thomalla (2011), community resilience is often strengthened through organized advocacy, as evidenced by how communities use digital platforms to address environmental hazards, illustrating the potential of collective action in fostering regulatory change.

2.7 Chapter summary

This literature gives information about health hazards, safety impacts, environmental impacts of roadside fabrication workshops to the neighborhoods and community perception and engagement. Therefore, enhancing community engagement and awareness initiatives will also be critical in driving meaningful change in these neighborhoods.

CHAPTER THREE: METHODOLOGY

3.1 Introduction

This chapter provides a clear framework for assessing the Health, Safety, and Environmental (HSE) impacts of roadside fabrication workshops on nearby communities. It comprises of research design, study population, study sample, data collection techniques, data analysis and study limitations.

3.2 Research design

Research design is the framework of research methods and techniques chosen by a researcher to conduct a study (Myers,2010). This outlines how data was collected and analyzed to effectively address specific objectives. This research adopted a quantitative approach but rely on questionnaire and survey responses to quantify perceived HSE impacts of roadside fabrication workshops on the nearby communities. Below are some advantages of quantitative approach;

- a) Focus on quantifying and measuring phenomena.
- b) Usually uses larger sample sizes.
- c) Typically emphasizes precision and objectivity.
- d) Data analysis involves statistical analysis and hypothesis testing.
- e) Results are presented numerically and statistically.

3.3 Study population and study sample

The study was focused on infinite population along Katwe road which consists of two main groups: roadside fabrication workshops workers and community members in the vicinity.

A sample size of 40 respondents was considered in the study area, aiming to achieve a statistically significant representation of responses. The stratified random sampling was carried out to ensure diversity among respondents based on workshop types (e.g., welding, woodworking, painting) and residents at varying proximities (e.g., within 100m, 200m, 500m). This design was to help compare perceptions of HSE risks according to the workshop type and the distance of residents from these workshops.

3.4 Data collection techniques

The project used questionnaires with closed-ended questions, using 5-point Likert scale from "1- strongly disagree" to "5- strongly agree," to quantify perceptions and experiences of HSE impacts

among participants. In-person survey was conducted to improve accuracy, with assurances of confidentiality and a brief explanation of the study's goals.

3.5 Data analysis

The data collected from 40 respondents was analyzed using simple quantitative methods to understand participants' views and experiences about health, safety, and environmental (HSE) issues. The responses were coded and entered into Smart-PLS software. This tool helped in calculating important statistics, such as averages, variability, and relationships between different factors, hence providing a clear summary of the findings.

In the study, Excel was employed to perform a descriptive analysis of the social demographic data. This involved computing frequencies and percentages to present an overview of the demographic attributes of the participants, including age and gender among others.

Furthermore, Smart-PLS software was utilized to identify the major hazards of roadside fabrication workshops to the neighborhoods, which encompassed environmental impacts, health hazards and safety hazards, and their relationship with community perceptions and engagement. Through this analysis, key statistical measures such as the mean, standard deviation, as well as assessed the validity, collinearity, and correlations among the variables to understand their interrelationships

The results helped identify patterns and relationships related to environmental impacts, health and safety hazards, community perceptions and engagement in the fabrication workshops neighborhoods. This helped in designing targeted solutions to improve health, safety, and environmental conditions and encourage more community involvement.

3.6 Study Limitations

While this study aims to provide a complete understanding, a few challenges limited the results

- a) Some participants were not good at speaking English or the researcher's language fluently. To address this, interpreters or bilingual assistants were involved when needed.
- b) Low literacy rates in some areas in Uganda, the survey questions were made simple, with clear instructions and easy-to-understand language.
- c) Participants were having busy schedules, making it hard for them to take part in the survey. To improve participation, the survey was conducted at times and places that are convenient for them.

CHAPTER FOUR: DATA PRESENTATION AND DISCUSSIONS

4.1. Introduction

This chapter presents social demographic and measurement models. It transformed the raw data into clear, understandable information. By utilizing tables, charts, and graphs, key trends and patterns that emerged from the analysis were illuminated. More importantly, the meaning behind these results were explored, drawing connections to the research questions and already established data. This discussion highlighted the significance of the findings that were used to acknowledge any limitations encountered and propose avenues for future research endeavors.

4.2 Respondent Social Demographic

4.2.1 Gender

Out of the 40 respondents, 52.5% were male, while 47.5% were female as shown in the table 4.1. This fairly balanced distribution suggests that both men and women are exposed to the effects of roadside workshops. Men may face direct risks from working in the workshops, while women may be more affected by environmental exposure such as noise and air pollution (WHO, 2021). *Table 4.1 Gender*

Gender	Frequency	Percent (%)
Male	21	52.50
Female	19	47.50
Total	40	100

4.2.2 Respondents Age

The majority of respondents were in the age group of 18–30 years (60.0%), followed by those aged 32–50 years (30.0%) and above 50 years (10.0%) as shown in the figure 4.1. Younger adults are often more active in both the labor market and social commentary and are more likely to be impacted by environmental hazards in urban communities (UN-Habitat, 2020).

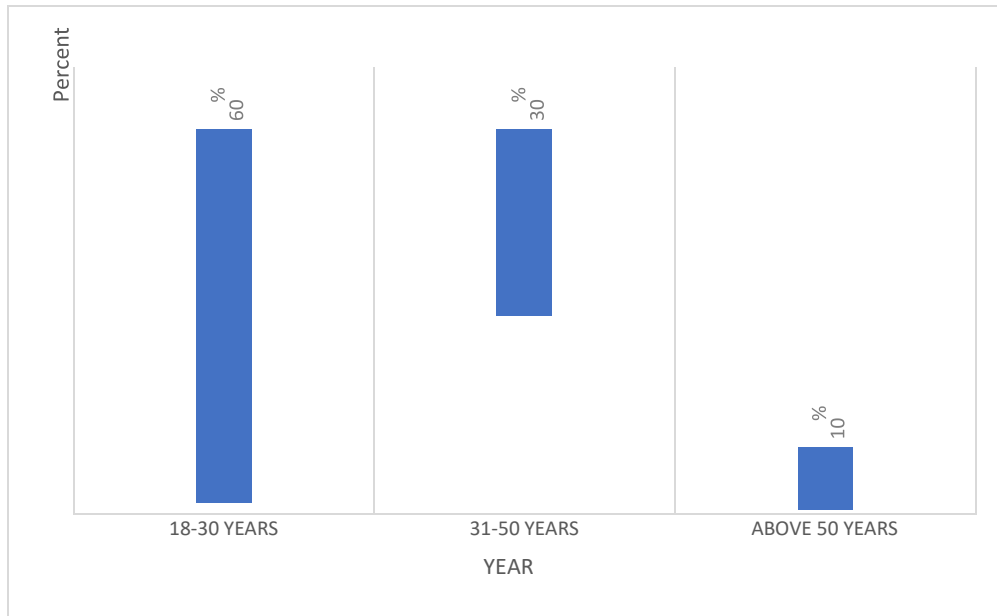


Figure 4.1 Age of respondents

4.2.3 Religion of respondents

The findings show that 75.0% of the respondents were Christians, while 25.0% were Muslims. These findings highlight the predominance of Christianity within the demographic profile of the survey participants which is line with the fact that Uganda is a Christian dominated country as shown in the figure 4.2 (Uganda Bureau of Statistics (UBOS), 2020).

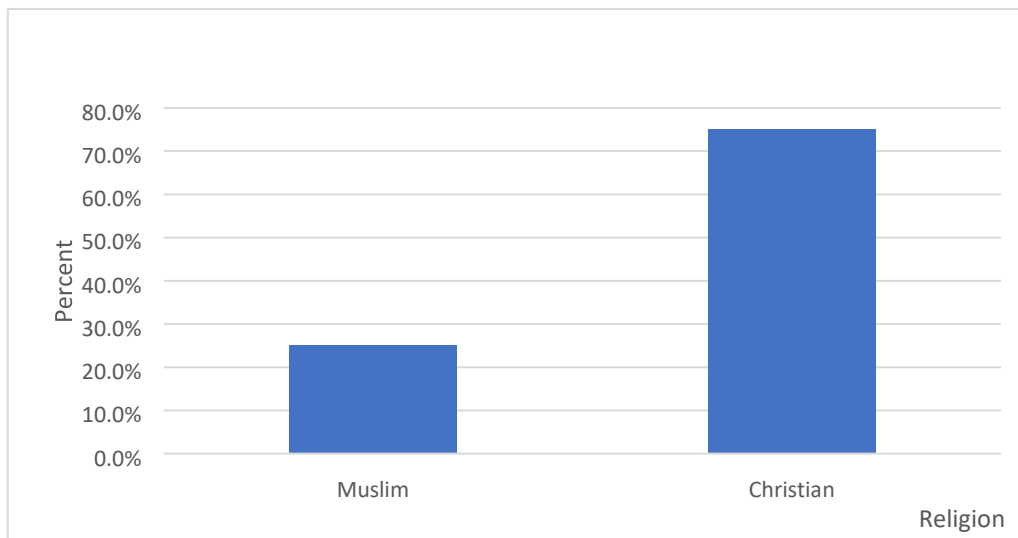


Figure 4.2 Religion of respondents

4.2.4 Level of Education

From Figure 4.3, about 47.5% of respondents had secondary education and 32.5% had tertiary education, suggesting a moderately literate community. However, many workshop workers may lack formal education, limiting their awareness of safety and health risks. In contrast, educated residents are more likely to recognize hazards and advocate for safer practices (UNESCO, 2018).

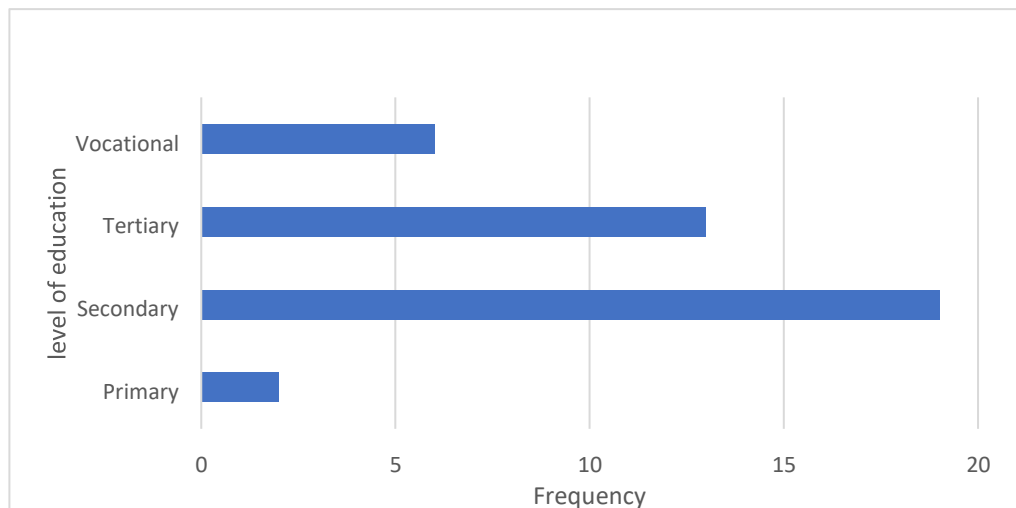


Figure 4.3 Level of education

4.2.5 Nationality of respondents

The overwhelming majority of participants (87.5%) were Ugandans as shown in Table 4.2. This is expected given the localized nature of the study. Nationality may influence perception, especially in urban settings where immigrants may have different levels of access to information or services (ILO, 2019).

Table 4.2 Nationality of respondents

Nationality	Frequency	Percent
Ugandan	35	87.5%
Non-Ugandan	5	12.5%
Total	40	100.0%

4.2.6 Marital status

With 45.0% single, 37.5% married, and the rest either divorced or widowed as shown in Figure 4.4, marital status may influence household responsibilities and time spent at home, thus affecting levels of exposure to pollution or noise from nearby workshops.

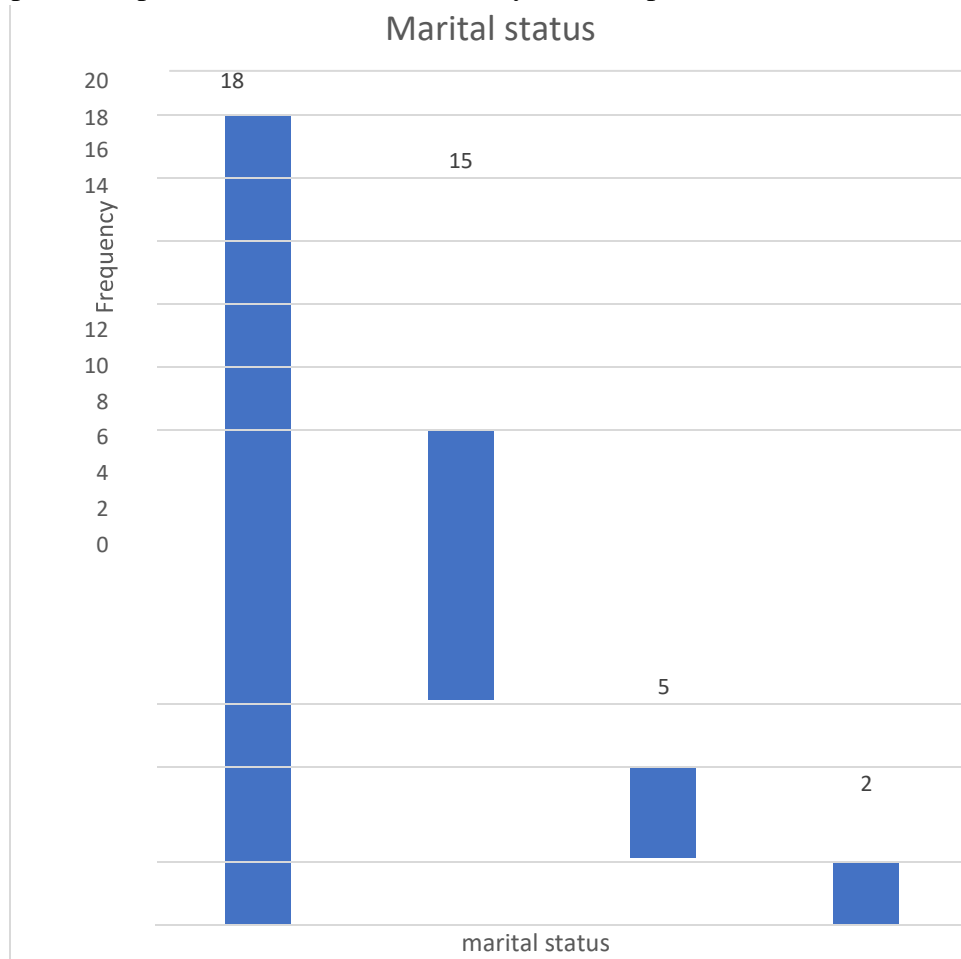


Figure 4.4 Marital status

4.2.7 Distance from the workshops

A significant portion (45.0%) of respondents resided within 500–1000 meters of the fabrication workshops as shown in Figure 4.5. Proximity is a key determinant in assessing exposure to environmental pollutants, including noise, dust, and hazardous fumes. Living closer to workshops increases the risk of negative health and safety outcomes (Chen et al., 2020).

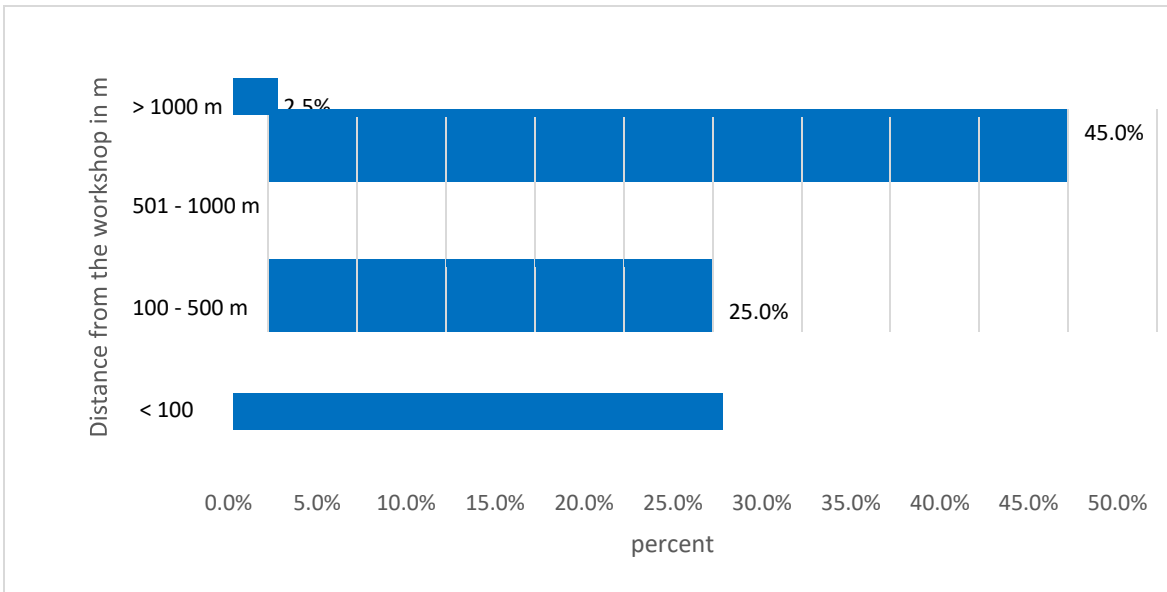


Figure 4.5 Distance from the workshops

4.2.8 Employments status

Self-employment (45.0%) and student status (40.0%) were the most common employment categories as showed in the Figure 4.6, Informal employment is a dominant sector in many African urban centers and is often associated with increased environmental health risks due to limited regulation and occupational safety (ILO, 2021).

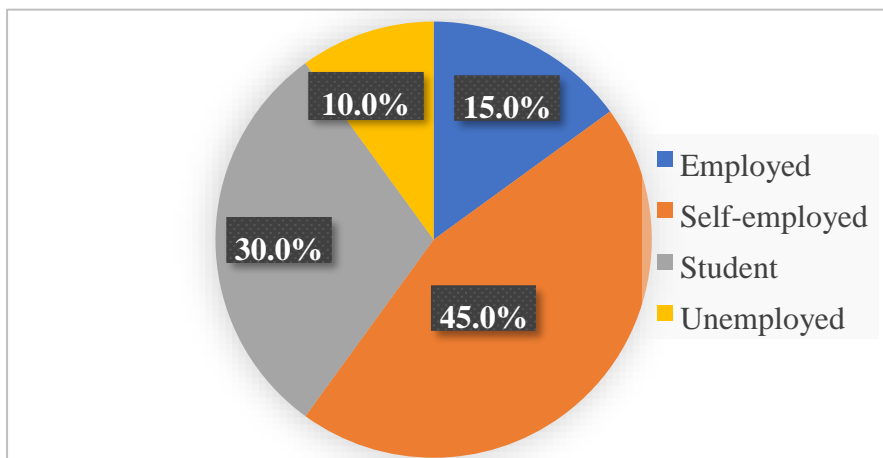


Figure 4.6 Employments status

4.2.9 Duration of living near the workshops

Most respondents (75.0%) had lived near the workshops for more than one year, with 15.0% reporting more than a decade. Duration of exposure is directly related to the cumulative health and

environmental impacts experienced by residents. Long-term exposure is particularly concerning in areas where air and noise pollution are persistent.

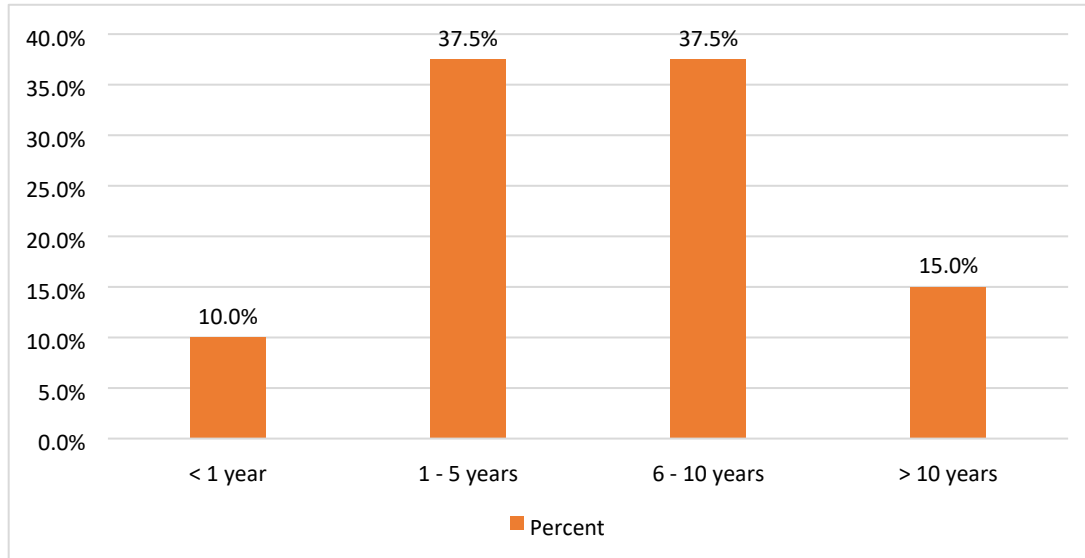


Figure 4.7 Duration of living near the workshops

4.3 Assessing environment, health and safety hazards of roadside fabrication workshops to the neighborhoods

To conduct the assessment, the measurement and the structural models were established as detailed below.

4.3.1 Measurement Model

The measurement model in PLS-SEM specifies the relationships between latent variables and their observed indicators. Evaluation of the measurement model includes indicator reliability, internal consistency, convergent validity, and discriminant validity. Indicator reliability, outer loadings should be ≥ 0.70 . Indicators with lower loadings may be retained if other quality criteria are met. Internal consistency is measured using Composite Reliability (CR), where values between 0.70 and 0.95 are considered acceptable. Convergent validity is evaluated using the Average Variance Extracted (AVE). A value ≥ 0.50 indicates that a latent construct explains more than half of the variance of its indicators (Hair et al., 2022).

Construct reliability and validity

In PLS-SEM, CFA is performed as part of validating the reflective measurement model. The goal is to confirm that the indicators relate strongly to their corresponding latent variables. Adequate factor loadings (>0.70), high AVE, and CR are essential to support construct validity (Hair et al., 2022). In the measurement model, the results retained have factor loadings above 0.6 as presented in Figure 4.8

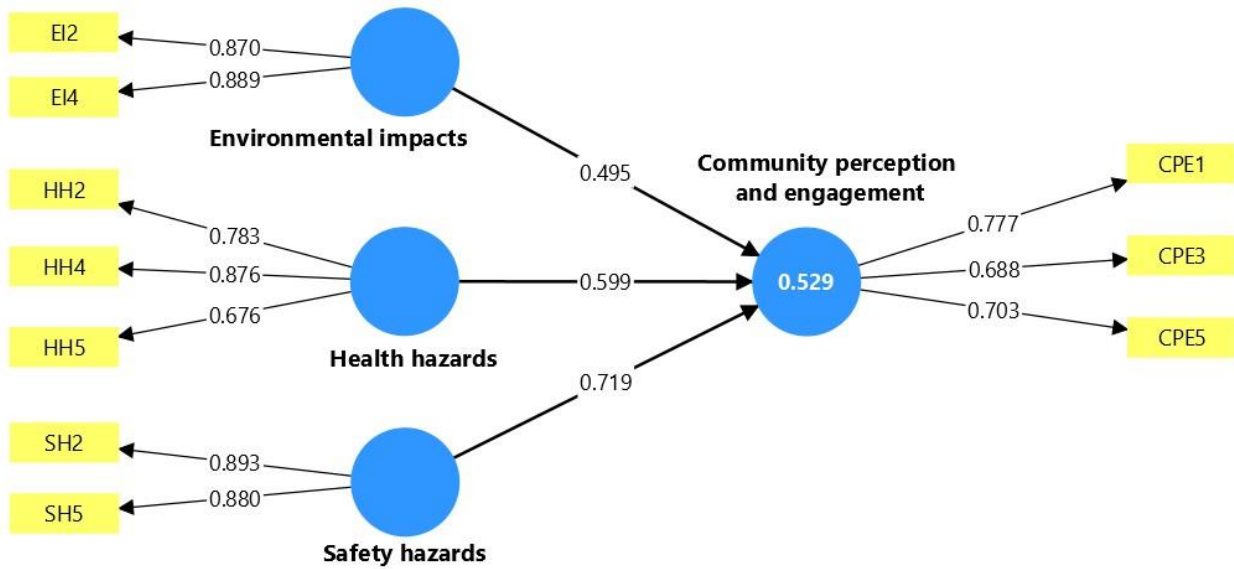


Figure 4.8 Measurement model

Table 4.3 Factor loading

	Community perception and engagement	Environmental impacts	Health hazards	Safety hazards
CPE1	0.777			
CPE3	0.688			
CPE5	0.703			
EI2		0.870		
EI4		0.889		
HH2			0.783	
HH4			0.876	
HH5			0.676	
SH2				0.893
SH5				0.880

Convergent Validity

Convergent validity confirms that indicators measuring the same construct are highly correlated. This was evaluated using three metrics: Cronbach's Alpha, Composite Reliability, and Average Variance Extracted (AVE). Hair et al. (2019) suggests that for convergent validity, factor loadings should be above 0.5, indicating each question significantly contributes to its intended concept. Additionally, composite reliability for all measures should exceed 0.6, and Cronbach's Alpha should be greater than 0.6, both signifying strong internal consistency within the measurement scales. In this study, all these criteria were met as shown in table 4.4, supporting the validity of this measurement model.

Table 4.4 Reliability and validity

	Cronbach's alpha	Composite reliability (rho_a)	Composite reliability (rho_c)	Average variance extracted (AVE)
Community perception and engagement	0.545	0.548	0.767	0.524
Environmental impacts	0.708	0.710	0.872	0.774
Health hazards	0.680	0.717	0.824	0.613
Safety hazards	0.728	0.729	0.880	0.786

Fornell-Larcker Criterion

According to Fornell and Larcker (1981), to meet the Fornell-Larcker criterion, the square root of the AVE (diagonal values) for each construct must be greater than the correlations with other constructs (off-diagonal values). This indicates that each construct shares more variance with its indicators than with other constructs, supporting discriminant validity, Table 4.5. Based on the values, the Fornell-Larcker criterion was met.

Table 4.5 Fornell-Larcker criterion

	Community perception and engagement	Environmental impacts	Health hazards	Safety hazards
Community perception and engagement	0.724			
Environmental impacts	0.495	0.880		
Health hazards	0.599	0.536	0.783	
Safety hazards	0.719	0.596	0.760	0.887

Correlation

According to Cohen (1988), interpreting correlation coefficients is essential for understanding the strength and direction of relationships between variables. A correlation coefficient (r) of 0 indicates no correlation. Values between 0.00-0.25 suggest a weak correlation, 0.26-0.50 indicate a moderate correlation, 0.51-0.75 suggest a strong correlation, and 0.76–0.99 indicate a very strong correlation. A perfect correlation ($r = 1$) means a complete linear relationship between variables.

In Table 4.6, Community Perception and Engagement, as expected, shows a perfect correlation ($r = 1$) with itself, as do the variables Environmental Impacts, Health Hazards, and Safety Hazards. Beyond these self-correlations, Community Perception and Engagement demonstrates a moderate positive correlation with Environmental Impacts ($r = 0.495$), suggesting that greater community awareness and involvement are moderately associated with increased environmental concerns, possibly due to more effective identification and reporting of such impacts.

Further, Community Perception and Engagement shows a strong positive correlation with both Health Hazards ($r = 0.599$) and Safety Hazards ($r = 0.719$). This suggests that higher levels of community engagement may be linked to increase recognition or reporting of health and safety risks, emphasizing the role of community vigilance in identifying hazards.

Environmental Impacts also show strong positive correlations with Community Perception and Engagement, Health Hazards, and Safety Hazards ($r = 0.495$, 0.536 , and 0.596 respectively). This indicates that communities that are more informed and actively involved in mitigation efforts may experience and report environmental issues and associated hazards more frequently, underlining the interconnected nature of these variables.

Health Hazards exhibit strong positive correlations with Community Perception and Engagement and Environmental Impacts, and a very strong correlation with Safety Hazards ($r = 0.760$). This suggests a tight interlink between health and safety risks within the community, highlighting the cumulative effect of environmental and safety issues on public health.

Lastly, Safety Hazards show strong positive correlations with Community Perception and Engagement and Environmental Impacts ($r = 0.596$ and 0.719), and a very strong correlation with Health Hazards. These relationships reinforce the conclusion that improving community awareness and reducing environmental impacts can positively influence health and safety outcomes.

Table 4.6 Correlations

	Community perception and engagement	Environmental impacts	Health hazards	Safety hazards
Community perception and engagement	1.00			
Environmental impacts	0.495	1.00		
Health hazards	0.599	0.536	1.00	
Safety hazards	0.719	0.596	0.760	1.00

R-Square (R²)

This measures the proportion of variance in the dependent variable that can be explained by the independent variables in a model. It reflects the explanatory power of the model: an R² value of 0.75 or higher is considered substantial, 0.50 is moderate, and 0.25 is weak (Hair et al., 2019). In Smart-PLS, R² values are provided for endogenous constructs within the structural model, helping to evaluate how well the model explains the target constructs.

Based on the results presented in Figure 4.8, the R² value for Community Perception and Engagement is 0.529. This indicates that approximately 52.9% of the variance in Community Perception and Engagement is explained by the variables Environmental Impacts, Health Hazards, and Safety Hazards. According to the guidelines by Hair et al. (2022), this R² value represents a moderate level of explanatory power.

This finding suggests that while Environmental Impacts, Health Hazards, and Safety Hazards play a significant role in shaping Community Perception and Engagement regarding the environment, health, and safety around fabrication workshops, there are still other factors outside the model that influence this perception.

Cross Loadings

Cross loadings compare an indicator's loading on its associated construct to its loadings on other constructs. An indicator should load higher on its own construct than on others to confirm discriminant validity. The results in Table 4.7, shows that factor loading of all items is stronger on the underlying construct to which they belong instead of other constructs in the study (Hair et al., 2019).

Table 4.8 Cross loadings

	Community perception and engagement	Environmental impacts	Health hazards	Safety hazards
CPE1	0.777	0.216	0.604	0.556
CPE3	0.688	0.520	0.388	0.466
CPE5	0.703	0.346	0.284	0.542
EI2	0.419	0.870	0.392	0.485
EI4	0.451	0.889	0.545	0.562
HH2	0.383	0.531	0.783	0.589
HH4	0.570	0.493	0.876	0.680
HH5	0.423	0.229	0.676	0.500
SH2	0.655	0.736	0.638	0.893
SH5	0.620	0.310	0.712	0.880

Collinearity

According to Zygiaris et al. (2022), the tolerance value and the variance inflation factors (VIFs) are used to assess the level of multicollinearity among the independent variables. From the results in the Table 4.8, all variables have VIF values below 5, which indicates that there is no significant multicollinearity affecting the regression estimates (Aguinis et al., 2016). This is a good sign, as it suggests that each predictor provides unique information to the model that is not overly redundant with the other predictors. Therefore, the VIF values in the analysis suggest that multicollinearity

is not a concern for this model, and the predictors can be considered to provide distinct and valuable information in predicting the outcome variable.

Table 4.8 Collinearity

	VIF
CPE1	1.221
CPE3	1.091
CPE5	1.187
EI2	1.429
EI4	1.429
HH2	1.595
HH4	1.668
HH5	1.153
SH2	1.487
SH5	1.487

4.3.2 Structural Model Analysis

After establishing acceptable reliability and validity in the measurement model, the next step involved examining the relationships among the constructs in the structural model. Following the recommendations of Hair et al. (2022), the evaluation focused on the coefficient of determination (R^2), the path coefficients (β), and their corresponding t-values, using a bootstrapping procedure with 5,000 resamples. Bootstrapping enhances the robustness of the analysis by generating multiple resamples from the original dataset, allowing for accurate estimation of the stability and significance of the path coefficients.

The structural model is presented in Figure 4.9, with the path coefficients detailed in Table 4.9. From the results, the relationship between Environmental Impacts and Community Perception and Engagement was ($\beta=0.089$, $t=0.695$, $p=0.487$). Although positive, this coefficient is relatively weak according to Hair et al. (2022). The associated p-value is 0.487, which is greater than the conventional threshold of 0.05, indicating that the relationship is not statistically significant. Therefore, while a positive trend exists, it cannot be confidently generalized. This contrasts slightly

with previous findings by Baffour (2018), who reported a more significant influence of environmental concerns on community engagement.

Similarly, Health Hazards demonstrate a positive relationship with Community Perception and Engagement was ($\beta=0.107$, $t=0.581$, $p=0.561$). However, the p-value of 0.561 again exceeds 0.05, implying that the relationship is also not statistically significant. This suggests that, although health hazards are perceived to increase community engagement, the effect is weak and not strong enough to be statistically validated in this model. While Baffour (2018) suggested a stronger link, this study findings highlight the potential influence of contextual factors or sample differences.

In contrast, Safety Hazards show a strong and statistically significant relationship with Community Perception and Engagement was ($\beta=0.585$, $t=2.888$, $p=0.004$). The strong positive beta indicates that safety concerns are a key driver of community awareness and engagement around fabrication workshops. This significant relationship reinforces the argument that visible, tangible risks such as traffic hazards and accidents, are more likely to mobilize community action compared to less immediate concerns like environmental or health hazards.

In summary, while all paths show a positive direction, only the relationship between Safety Hazards and Community Perception and Engagement is statistically significant, emphasizing the critical role safety issues play in shaping community responses.

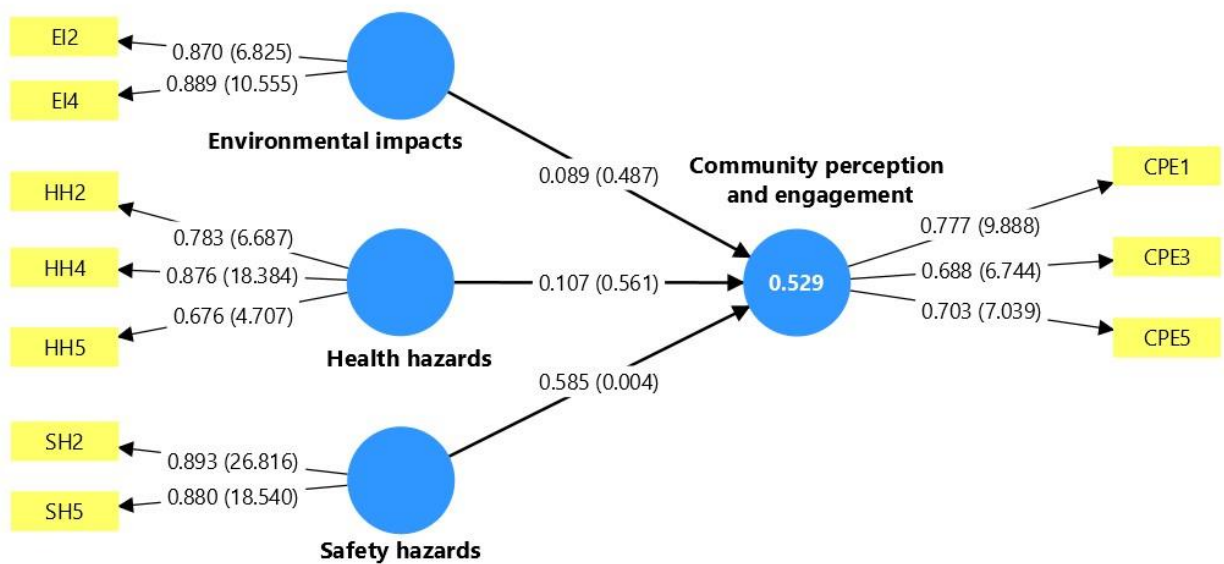


Figure 4.9 Structural model

Table 4.9 Path coefficient

Relationship	Original sample (O)	Sample mean (M)	Standard deviation (STDEV)	T statistics (O/STDEV)	P values
Environmental impart --> community perception and engagement	0.089	0.111	0.128	0.695	0.487
Health hazards --> community perception and engagement	0.107	0.148	0.184	0.581	0.561
Safety hazards --> community perception and engagement	0.585	0.544	0.203	2.888	0.004

CHAPTER FIVE: CONCLUSION AND RECOMMENDATIONS

5.1 Conclusion

This study investigated the environmental, health, and safety impacts of roadside fabrication workshops on surrounding neighborhoods, focusing on three specific objectives.

Firstly, regarding relationship between the environment and roadside fabrication workshops, the findings revealed moderate environmental impacts linked to the activities of roadside fabrication workshops ($r = 0.495$). Although community engagement demonstrated only a modest correlation with environmental impacts, it is evident that environmental degradation, including water pollution and visual pollution (clutter, waste materials), is a concern in the vicinity of these workshops that can be addressed through awareness and social platforms.

Secondly, concerning the relationship between the health and roadside fabrication workshops, health hazards showed a strong positive correlation with community perception and engagement ($r = 0.599$), although the structural model revealed that this relationship was not statistically significant ($\beta = 0.107$, $p = 0.561$). This suggests that while health issues such as noise pollution, physical injuries, sanitation and hygiene are recognized, they may not always trigger substantial community mobilization unless combined with more visible hazards.

Thirdly, regarding relationship between the safety and roadside fabrication workshops, safety hazards showed a strong and statistically significant relationship ($\beta = 0.585$, $p = 0.004$) with community perception and engagement. Safety issues such as electrical hazards (exposed wires, faulty equipment) and accidents were major concerns, highlighting that physical safety threats are key drivers of community awareness and action around roadside fabrication workshops.

Overall, while environmental and health concerns exist, safety hazards most strongly influence community engagement, indicating that immediate and visible risks tend to galvanize public response more than less tangible issues.

5.2 Recommendations

Based on the findings of this study, several key recommendations are proposed to improve the health, safety, and environmental conditions surrounding roadside fabrication workshops (RSFWs) and their impact on neighboring communities:

Prioritize safety management: The study revealed that safety hazards are the most significant drivers of community engagement. Therefore, it is critical to enforce stricter safety standards in

RSFWs. Regulatory authorities such as Kampala Capital City Authority (KCCA) should conduct regular inspections to ensure compliance with fire and electrical safety guidelines. Workshop owners should be mandated to install functional fire extinguishers, use certified wiring systems, and properly ground all electrical equipment to reduce risks of fire outbreaks and electrocution.

Community-based awareness programs: While the community demonstrated high responsiveness to immediate safety threats, there was limited engagement with long-term environmental and health concerns. To address this gap, sensitization campaigns should be launched to raise awareness about the less visible risks posed by RSFWs, such as chemical exposure and air pollution. These programs should involve local leaders, health officers, and environmental experts, and be delivered through public forums, radio programs, schools, and social media platforms to reach a wider audience.

Infrastructure upgrades: The study identified poor workshop structures and lack of containment as contributors to environmental and health risks. Therefore, there is a need to encourage investment in improved infrastructure. Workshop owners should be supported—through tax incentives or microloans—to upgrade their facilities by enclosing work areas, constructing proper waste disposal units, installing sound-dampening barriers, and ensuring access to sanitation facilities. These upgrades will not only reduce noise and chemical pollution but also protect workers and the surrounding community from direct exposure.

Use of Reporting Tools: To promote community involvement in monitoring RSFW activities, local governments and civil society organizations should develop and implement easy-to-use reporting mechanisms. These could include digital platforms, mobile applications, or SMS-based systems that allow residents to report safety violations or environmental concerns in real time. These tools would empower the public and enhance accountability among workshop operators.

Expand Research Scope: This study focused on Katwe Road, Kampala, and involved a relatively small sample. To gain a more comprehensive understanding of the impact of RSFWs, future research should expand to include a larger geographical area and cover diverse types of fabrication activities. Longitudinal studies could also be conducted to assess the long-term effects of exposure to RSFW-related hazards on community health and the environment.

APPENDICES

A1. Questionnaire survey

Dear respondents,

My name is Joel Ayii Philip, an undergraduate student in Mechanical Engineering at the College of Engineering, Makerere University. I am currently conducting a research study titled, "*assessing health, safety, and environment of roadside fabrication workshops to the neighborhoods.*"

The survey consists of questions about health hazards, safety hazards and environmental impacts of roadside fabrication workshops to the neighborhoods, the community perception and engagement.

Please answer each question to the best of your ability, and feel free to provide any additional feedback you may have. Your responses will be kept strictly confidential and used solely for the purpose of this research study. You will not be identified in any reports or publications resulting from this research.

Your participation is voluntary and greatly appreciated. By completing this survey, you are contributing to a better understanding of the health, safety, and environmental impacts of roadside fabrication workshops on nearby communities.

Thank you for your time and consideration.

Joel Ayii Philip

Phone number: 0789538548 Email:

joelayii64@gmail.com **Section A:**

SOCIAL DEMOGRAPHICS

Please complete the following questions. The information provided will help in statistical tabulations (please indicate your response by ticking the appropriate box).

1	Gender	Male	<input type="checkbox"/>	Female	<input type="checkbox"/>				
2	Age	18-30	<input type="checkbox"/>	31-50	<input type="checkbox"/>	Above 50	<input type="checkbox"/>		

3	Religion	Muslim		Christian		Other (specify)		
4	Level of education	Primary		Secondary		Tertiary		Vocational
5	Nationality	Ugandan		Non- Ugandan				
6	Marital status	Single		Married		Divorced		Widowed
7	Distance from the workshop	0 <100m		100-500m		500- 1000m		1000m >
8	Employments status	Employed		Self employed		student		unemployed
9	Duration of living near the workshops	0<1 year		1-5 years		5-10 years		10 years >

Section B: HEALTH HAZARDS

Please indicate your response by ticking the appropriate box.

Question	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
1. The community observes air pollution (e.g., dust, smoke, or fumes) in the vicinity of the workshop.					
2. Noise from the workshop affects daily activities in the community.					
3. I frequently notice chemicals (e.g., paint, solvents, or oils) that might pose a risk to health.					

4. I or someone in my household has experienced physical injuries caused by the workshop.					
5. The sanitation and hygiene practices at the workshop are observed to be satisfactory.					

Section C: SAFETY HAZARDS

Please indicate your response by ticking the appropriate box.

Question	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
1. I notice fire hazards (e.g., open flames, flammable materials) in the workshop area.					
2. The community observes electrical hazards (e.g., exposed wires, faulty equipment) near the workshop.					
3. The stability and structural soundness of the workshop buildings or sheds is a concern.					
4. The location of the workshop creates traffic risks (e.g., blocked sidewalks, congested roads).					
5. There have been reported accidents in the workshop that the community is aware of.					

Section D: ENVIRONMENTAL IMPACTS

Please indicate your response by ticking the appropriate box.

Question	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
1. The community has observed soil contamination near the workshop.					
2. The community believes water sources are being polluted by workshop activities.					
3. The air quality around the workshop is poor.					
4. The workshop contributes to visual pollution.					
5. The workshop engages in efforts to reduce environmental impacts.					

Section E: COMMUNITY PERCEPTION AND ENGAGEMENT

Please indicate your response by ticking the appropriate box.

Question	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
1. The community is aware of potential health risks associated with the workshop.					
2. The community's perception of the environmental impact of the workshop is negative.					
3. The workshop has created localized concerns for community households.					

4. The community has engaged with workshop owners to address these issues.					
5. Community advocacy through digital platforms in addressing these concerns is effective.					

Thank you for your valuable input and consideration.

A2. Project Timeline

ACTIVITY	AUG	SEP	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY
Concept generation										
Visiting the RSFWs										
Proposal writing										
Introduction										
Literature review										
Methodology										
Proposal presentation										
Data collection tools										
Data collection										
Data analysis										
Report writing										

Project presentation											
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A3. Budget

Particulars	Estimated amount (UGX)
Transport	100,000
Stationery and printing questionnaires	80,000
Miscellaneous costs	170,000
Internet access	60,000
Total amount	410,000

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