ORIGINAL RESEARCH ARTICLE

Control of chemical risks to safety and health of workers in paint manufacturing industries in Nairobi County, Kenya

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Abstract

One of the long-held industries globally and locally is the paint manufacturing yet there are risks especially due to its heavy use of hazardous chemicals. A sample of 35 out of the 55 countries globally contained paints with high lead levels. In Kenya 6979 occupational accidents had been reported in the year 2023 with 380 fatalities in addition to a suspected 512 cases from occupational diseases most of which were caused by exposure to chemicals and hazardous substances. The main objective of the study was establishing control measures in place against risks to safety and health posed by chemicals used in paint manufacturing industries in Nairobi County. This study was carried out using descriptive research design that adapted both quantitative and qualitative approaches. Selected paint industries within Nairobi County, Kenya were sampled through random sampling targeting 351 members of the management, and workers in the production and storage areas. Data was collected using observation guided by checklists, questionnaires, desktop surveys, face-to-face interviews and focused group discussions. The study found out that only 15% of the sampled paints manufacturing industries had adequately controlled risks to safety and health posed by chemicals and hazardous substances. Inferential analysis results indicated that control measures for paint manufacturing companies in Kenya were statistically significant, $R^2 = 0.078$ $F(1, 319) = 21.863$, p-value $< .05$. This shows 7.8% of occupational health and safety status in paint manufacturing industries in Kenya is attributed to control measures in place while the remaining 92.2% can be attributed to other factors not included in the study and the error terms. It can be concluded from findings that there were limited controls in place against chemical risks to safety and health in most of the paint manufacturing industries in Nairobi County. The study recommended that paint manufacturing firms should ensure various control measures against risks to safety and health posed by hazardous chemicals are put in place according to the hierarchy of controls.

Keywords: Occupational safety and health, paint industry, chemical safety, chemical controls

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1.0 Introduction

Chemicals are an essential part of a country's manufacturing industry and form part of people's lives. Nearly all workers today are exposed to some sort of chemical hazards since chemicals are used in all industries. The manufacture and use of some chemicals have however the potential to pose major risks to the safety and health of workers. In fact, chemical hazards are the most serious health hazard for workers today. For the majority of chemicals used in the workplace, little or nothing is known, by the workers, about their possible immediate or long-term effects (Han et al., 2024). To date, out of a universe of over 60,000 commercially used chemicals, approximately 600 have been evaluated by a variety of organizations and countries, and occupational exposure limits established for airborne contaminants (ILO, 2021). The first line of defense against chemicals is to learn as much as possible about the substances one handles and to prevent exposure to them, no matter how safe one may think they are, or how safe one may have been told they are. An effective control of chemical risks at the workplace requires an efficient flow of information from the manufacturers or importers to the users of or those who handle chemicals, on potential hazards and the safety precautions to be taken. This flow of information should be followed by daily action by employers to ensure that the necessary measures are taken to protect workers, and consequently the public and the environment (WHO, 2021). Majority of the chemicals have the potential to cause acute and/or chronic effects on human beings which can be localized and/or systemic.

Paint is a mechanical dispersion of pigments or powders with a liquid or solvent known as a vehicle. The vehicle portion of the paint consists of a non-volatile portion and a volatile portion. After application of paint, the non-volatile portions of the vehicle (for example., resin polymers, film-formers, and binders) remain as a film on the coated surface, and the volatile portion evaporates (Salari et al., 2024). In addition to pigments and vehicles, paints contain other chemicals (called additives) that enhance their physical properties and make them easier to apply.

Organic solvents are widely used in industrial processes and in consumer products, mostly in the form of mixtures. They are found in paints, adhesive glues, coatings and degreasing agents, and in the production of dyes, plastics, textiles and pharmaceuticals. It can be presumed that a number of workers are exposed to organic solvents over a long period in their workplaces (Pereira et al., 2024). Commonly used solvents include, isopropanol, toluene, xylene, solvent mixtures such as white spirits and chlorinated solvents, methylene chloride, trichloroethylene, and perchloroethylene. The largest end user is the coatings industry where solvents play an important role in the quality and durability of paints and varnishes (Singhal et al., 2022). Organic solvents application grew to be wide and diverse in both developed and developing countries. The health effects of organic solvents have been known for more than a century. The introduction of chlorinated solvents in the 1920s led to reports of toxicity. Although solvents number in thousands, only a few have been tested for neurotoxicity (Thomas et al., 2022).

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Indoor air exposure of workers in paint manufacturing industries, painters and occupants to paint emissions is a health concern. Conventional paints contain volatile organic compounds (VOCs) that vaporize, dispersing into the air we breathe and exposure to VOCs can result in irritation of the eyes, nose, and skin, respiratory problems, headaches, nausea, and dizziness (Njogu et al., 2019). Paint and coating manufacture involve materials handling which may be toxic, flammable or explosive substances; and physical agents such as electric shock, noise, heat and cold (Bandery Elsayed et al., 2024). Some of the chemicals used in paint manufacturing industries are hazardous and are suspected to be carcinogens, teratogens, mutagens or have the potential to cause neuropsychological, dermatologic, pulmonary, cardiovascular effects. Others may have the ability to disrupt the endocrine system or cause effects to reproductive systems among other effects.

A study by Samanta and Gochhayat (2023) in India showed that workers in chemical industries had high risk exposures and government surveys indicated close to 50 cases of chemical hazards and accidents in the Northern India factories. The study concluded that there were poor controls in place with weak legislation making improvements on chemical risks hard to avoid.

Olufunsho Awodele (2014) in a study on occupational hazards and safety measures amongst the paint factories conducted in Nigeria, Lagos West Senatorial District, found that more than 40% of respondent do not use Personal Protective Devices (PPDs), and of those who do, only 25% use these devices regularly. Olufunsho Awodele (2014) went further to conclude that the results highlight a lack of adequate work safety practices in the paint factories.

In Kenya, Nyawira et al., (2022) study indicated that most focus of OHS in the health sector focused on physical hazards and risks. Additionally, in the study, the rights of health workers in terms of remunerations received more attention than their exposure to chemical and biological hazards and risks. Another study by Mwai et al., (2023) in paint industries showed that workers were exposed to high levels of lead and reported accidents that were however not acted upon by both factory authorities and government offices where any such cases were commonly reported, with recently in Kiambu County a paints mixture that ignited causing burns to 3 workers at a construction site with the paints company charged for improper mixing of chemicals (Mbuku, 2024; Ayaga et al., 2024). The purpose of this study was to assess the control measures to risks to safety and health posed by chemicals in the paints manufacturing industries in Nairobi County, Kenya. Gaps in chemical safety risk controls in the industry were also identified which assisted in determining the measures necessary to raise the standards and compliance levels on chemical usage in order to prevent effects of chemicals on the safety and health of workers in Kenya.

2.0 Materials and methods

2.1 Study location

The study area was Nairobi County, which is located in the southern part of Kenya. Nairobi County shares boundaries with three other counties namely; Kiambu, Machakos and Kajiado. The study

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was conducted in selected paint manufacturing industries in Nairobi County. The study site was selected because majority of paint manufacturing industries in Kenya are based in Nairobi County and the sample is representative of all paint-manufacturing industries. The study population included all workers in all paint-manufacturing industries in Nairobi County. 1755 workers were employed in 20 paint-manufacturing industries in Nairobi County by September 2024.

2.2 Research design

The study was carried out using a descriptive research design, which involved systematic collection and presentation of data to give a clear picture of the situation. In this study, the state of affairs was described and explained as it was and the findings reported. The design adapted both quantitative and qualitative approaches. Descriptive research design was chosen due to the cross-sectional nature of data collected.

Simple random sampling was used to select the participants from the members of the management, and workers in various production and storage areas, in each of the twenty selected paint manufacturing industries, in Nairobi County.

The Bartlett (2001) formula (1) was used to calculate the sample size.

$$s = \frac{x^2 NP(1-P)}{d^2(N-1)+x^2P(1-P)} \quad (1)$$

Where:

s= required sample size.

x^2 = the table value of chi-square for 1 degree of freedom at the desired confidence level (3.841).

N = the population size.

P= the population proportion (assumed to be .50 since this would provide the maximum sample size).

d = the degree of accuracy expressed as a proportion (.05)

$$s = \frac{3.841\times1755\times0.5(1-0.5)}{0.05^2\times(1755-1)+3.841\times0.5(1-0.5)} \quad (2)$$

$$s = 315$$

A shown in equation (2) above, the calculated sample size for this study from a population of 1755 was 315. The researcher decided to sample 351 in order to cater for the respondents who withdrew from the research.

With proportionate stratification, the sample size of each stratum is proportionate to the population size of the stratum. Strata sample sizes were determined using the following formula:

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$$n_h = (\frac{N_h}{N}) \times n \quad (3)$$

Where:
n_h is the sample size for industry h, N_h is the population size for industry h, N is total population size, and n is total sample size.

Using the above formula, the sample sizes for the industries, proportionate to the number of employees in each paint manufacturing industry, were found as provided in table 1. The response rate was 91.7%, that is, 322 out of 351.

Industry Code	Number of Workers	Number of Workers Sampled
PMI 1	431	86
PMI2	209	42
PMI3	510	102
PMI4	19	4
PMI5	57	11
PMI6	70	14
PMI7	38	8
PMI8	24	5
PMI9	25	5
PMI10	115	23
PMI11	20	4
PMI12	36	7
PMI13	45	9
PMI14	37	7
PMI15	24	5
PMI16	7	1
PMI17	15	3
PMI18	18	4
PMI19	17	3
PMI20	38	8

Table 1: Number sampled in Paint Manufacturing Industries in Nairobi County

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2.3 Data collection and analysis

2.3.1 Research instruments

Data was collected using structured questionnaires, observation guided by checklists and by conducting face-to-face interviews and focused group discussions (FGDs) with workers and key stakeholders.

2.3.2 Correspondent questionnaires

Questionnaires were designed in English and were administered by the study. This ensured that questions were interpreted to workers who didn't understand either English or the subject of the study.

2.3.2.1 Onsite observations

Observations were used as one of the data collection tools. The observed parameters included; activities involving the handling, transportation and use of chemicals, storage and disposal of chemicals and workers behavior within the industry. The study also observed the various controls in place such as PPEs, engineering controls, and the availability of means of communication of chemical safety information such as signs, symbols, posters and other means of communication that are visible.

2.3.2.2 Interviews and focused group discussions

In-depth interviews were carried out on the management team to obtain both qualitative and quantitative data. The focused group discussions (FGDs) were also carried on the participants to obtain both qualitative and quantitative data. This helped in verifying information that had been provided in the questionnaires and that which was obtained by observation.

2.3.2.3 Secondary data

In this study, relevant documents for example training records, medical examination reports, air quality monitoring reports, safety and health audit reports, fire safety audit reports, safety and health policy, risk assessment reports, safe work procedures, MSDS, permits to work, emergency response plans and evacuation procedures, inspection procedures, lists of hazardous substances and chemicals, records of PPEs and accident reports were reviewed to obtain secondary data.

2.3.2.4 Reliability of instruments

In this study, questions of stability and consistency were considered. The researcher ensured all research instruments were capable of yielding consistent results or data after repeated trials. Pre-testing of the instruments was carried out in one of the paint manufacturing industry located in Thika, Kiambu County. The researcher also attempted to minimize random errors that could arise from inaccurate coding, ambiguous instruments to the subjects, interviewer and interviewee fatigue and biases.

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2.3.2.5 Data processing and analysis

Data was collected and analyzed using SPSS and Microsoft Excel, whereas organized and coded data was used for cross tabulations to generate frequency distribution tables, graphs, pie charts, and percentages as well as inferential statistics for regression model.

3.0 Results and discussion

3.1 Respondents' demography

In the study, majority (74.5%) of the respondents were male, and 64.0% aged thirty years and below. Majority, 78.0%, of the respondents had only up to secondary education and 85.5% had less than ten years of experience in the industry. The results showed that most of the workers didn't have technical training and had less experience in the industry. A complete summary of the demographic background of this study is presented in Table 2.

Table 2: Demographic background of respondents used in the study.

Characteristics	Category	n (N= 322)	Percent (%)
Gender	Male	240	74.5
	Female	82	25.5
Age (years)	15-20 years	25	7.8
	21-30	181	56.2
	31-40	82	25.5
	41-50	25	7.8
	51-60	8	2.5
	> 60	1	0.3
Education level	Primary school	107	33.2
	Secondary school	144	44.7
	Certificate	26	8.1
	Diploma	27	8.4
	Bachelor's Degree	18	5.6
Work experience (years)	< 1	37	11.5
	1-5	121	37.6
	5- 10	116	36.0
	> 10	48	14.9

3.2 Controls of chemical safety risks

The objective of the study was to establish the controls put in place against risks to safety and health posed by chemicals used in paint manufacturing industries. The study sought to find out whether there are safe systems of work, proper storage, transport, handling and disposal of chemicals, and availability of emergency response plans and evacuation procedures in case of accident exposure to chemicals. The study also sought to find out if appropriate PPEs are provided and used to protect workers exposed to chemicals, and whether air quality monitoring is carried out in paint industries in Nairobi County as well as medical examination of workers.

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The general findings on control measures across the paint manufacturing industries is summarized in Table 3 with subsequent analysis for each item of control measure.

Table 3: Control measures in place

Control Measures in Place	Strongly agree (n) (%)	Agree (n) (%)	Neutral (n) (%)	Disagree (n) (%)	Strongly disagree (n) (%)	Total (n) (%)
There are safe systems of work such as permit to work systems, safe work procedures and safety and health policy, for hazardous non-routine work, hazardous routine work and general conduct of employees respectively.	10 (3.1)	46 (14.3)	69 (21.4)	145 (45)	52 (16.1)	322 (100)
Chemicals are stored in stores, cabinets or containers that are appropriate in terms of design and marking.	26 (8.1)	214 (66.5)	58 (18)	24 (7.5)		322 (100)
There are response plans, evacuation procedures in case of emergencies such as spillage or fire, and suitable emergency eye wash or showers and firefighting appliances are provided.	15 (4.7)	56 (17.4)	115 (35.7)	133 (41.3)	3 (0.9)	322 (100)
All employees are provided with adequate, effective and suitable personal protective clothing, appliances and equipment where applicable, which are properly maintained.	13 (4)	110 (34.2)	98 (30.4)	90 (28)	11 (3.4)	322 (100)
Workplace and biological monitoring are carried out periodically by designated health practitioners and air quality monitors respectively as appropriate.	16 (5)	47 (14.6)	23 (7.1)	148 (46)	88 (27.3)	322 (100)

3.2.1 Safe systems of work

In figure 1, 10 (3.1%) of the respondents strongly agreed that there were safe systems of work such as permit to work systems, safe work procedures and safety and health policy, for hazardous non-routine work, hazardous routine work and general conduct of employees respectively, 46 (14.3%) just agreed, 69 (21.4%) were neutral, 145 (45%) disagreed while 52 (16.1%) of them

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strongly disagreed with the statement. These results shows that majority of the respondents worked in organizations where there were no safe systems of work. This was also confirmed from the desktop reviews and interviews where results showed that very few industries 3 (15%) of the sampled industries had safe work procedures documented and available for dealing with hazardous substances. The study was also able to establish through the interviews and FGDs that some of the industries that had documented the safe systems of work had maintained the documents in the offices, and that majority of the workers were no aware of their contents. The study concluded that the documents were for public relations only since most of the workers who are expected to follow the systems had no idea that they existed. It was concluded in the FGDs that safe systems of work should be established so that there are standard procedures of various operations in the industry that take into considerations the safety and health of workers. It was also concluded from the FGDs that it is more important also to train and sensitize the workers on the safe systems of work and ensure the systems are implemented.

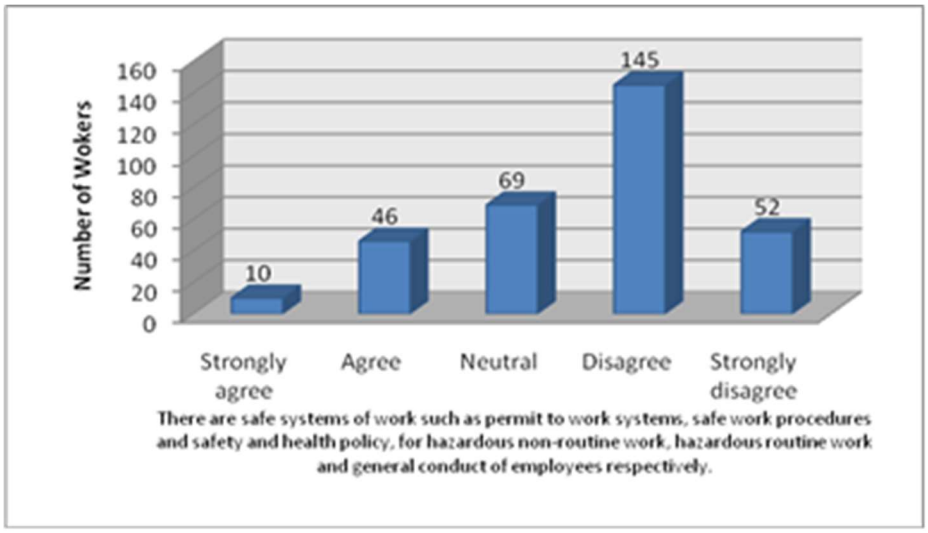

Figure 1: Safe systems of work

3.2.2 Chemical storage

The results from the study, figure 2, shows that majority 240 (74.5%) of the respondents were of the opinion that the chemicals were stored in stores, cabinets or containers that were appropriate in terms of design and marking. A small number of the respondents 58 (18%) were neutral while 24 (7.5%) had contrary opinion. However, this was contrary to the opinion of the study who found out that only a minority 3 (15%) of the sampled industries had stores and external storage areas that were safe with respect to construction, layout, security and control, while a majority of them had not met most of these standards. The study also found out that 4 (20%) of the sampled industries segregated hazardous substances correctly while 16 (80%) had not segregated them correctly or had not segregated them at all. Similarly, 5 (25%) of the sampled industries in the study had appropriate warning signs displayed in areas of storage and use of hazardous substances

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compared to 15 (75%) of them who had inappropriate warning signs displayed or did not have them at all. The study found out that only 1 (5%) out of the 20 industries that were sampled had maintained adequate cleaning and housekeeping levels. It was also observed that most of the highly flammable chemicals had not been stored in fire resistant stores, cupboards or containers. Majority of the stores had not been banded to contain any spillage. Some chemicals in some industries were found stored in parking areas, offices and within the production areas. It is important to note that most of the industries had provided signage-indicating presence of highly flammables and no smoking zones. It is therefore the conclusion of the study that from the above findings that most of the paint industries had not ensured proper chemical storage.

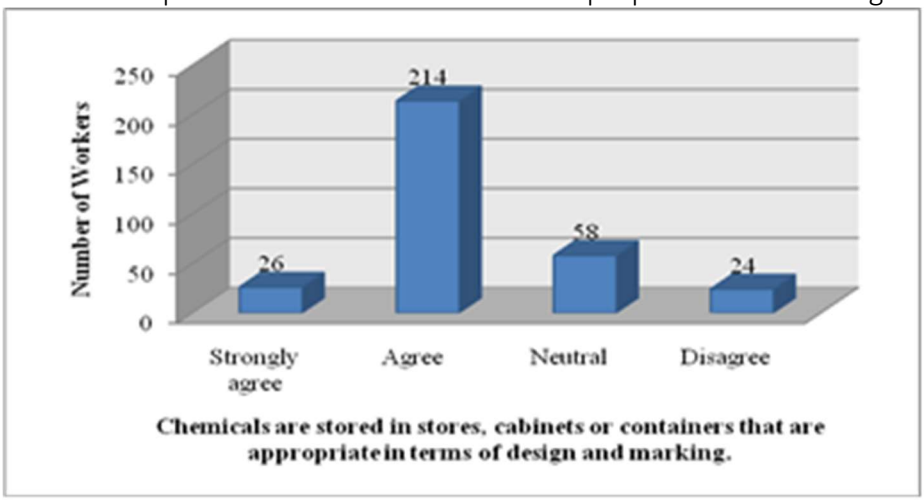

Figure 2: Storage of chemicals

3.2.3 Emergency preparedness

Emergency response plans and evacuation procedures in case of emergencies such as spillage or fire had been provided by a few industries. Emergency facilities such as emergency eye wash or showers and firefighting appliances had also been provided by a few industries. This was evident in figure 3 where 15 (4.7%) of the sampled employees strongly agreed on the availability of the plans, procedures and facilities, 56 (17.4%) just agreed, 115 (35.7%) were neutral, 133 (41.3%) disagreed 3 (0.9%) strongly disagreed. However, the study observed that majority 15 (75%) of the sampled industries in the study had adequate and appropriate fire appliances available, suitably located, accessible and maintained compared to 5 (25%) of them who either had inadequate or inappropriate appliances.

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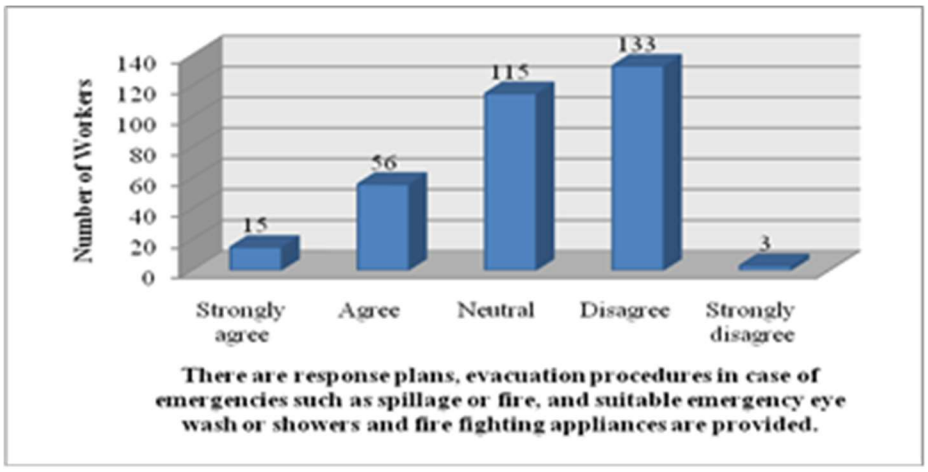

Figure 3: Response plans, evacuation procedures and emergency facilities

The study also found out that majority 17 (85%) of the sampled industries, either did not have specific procedures for dealing with spillages of all types of substances or did not have such procedures at all. A few 4 (20%) of the sampled industries had routine inspection procedures covering PPEs and procedures covering emergency showers and eye washes compared to 16 (80%) of them who had none. The study observed that majority of the industries had not provided emergency showers and eyewash facilities and that is the reason why they had not established inspection procedures for such facilities. Similar percentages were obtained with respect to routine inspection procedures covering first aid boxes. It is important to note that majority 16 (80%) of the sampled industries had routine inspection procedures covering fire appliances. This can be attributed to the fact that the industries understand the fire risks due to presence of highly flammable substances, and also the fact that some of the industries had experienced some fire incidences before. All of the sampled-out paints manufacturing industries did not use neutralizing compounds. This could be because most of the chemicals used are neither strong acids nor strong bases.

3.2.4 Personal protective equipment (PPE)

From the results it indicates 13 (4%), in figure 4, of the sampled employees strongly agreed that all employees were provided with adequate, effective and suitable personal protective clothing, appliances and equipment where applicable, which were properly maintained, 110 (34.2%) just agreed, 98 (30.4%) were neutral, 90 (28%) disagreed, while 11 (3.4%) strongly disagreed with the statement. Contrary to this, the study found out through observations and interviews that only a few 3 (15%) of the sampled industries had ensured suitable PPEs were provided and maintained. The study also found out that the same number of industries ensured the PPEs are used by employees. This means that 17 (85%) of industries either had unsuitable, inadequate or had not maintained PPEs. The study also found out from the interviews that a good number of the workers in paints industries do not understand some of the correct PPEs that should be used in the

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industry. In fact, most of them thought that dust mask instead of chemical respirator was the right PPE to provide protection against fumes and vapours from paints, although the study was able to advise them accordingly during the FGDs.

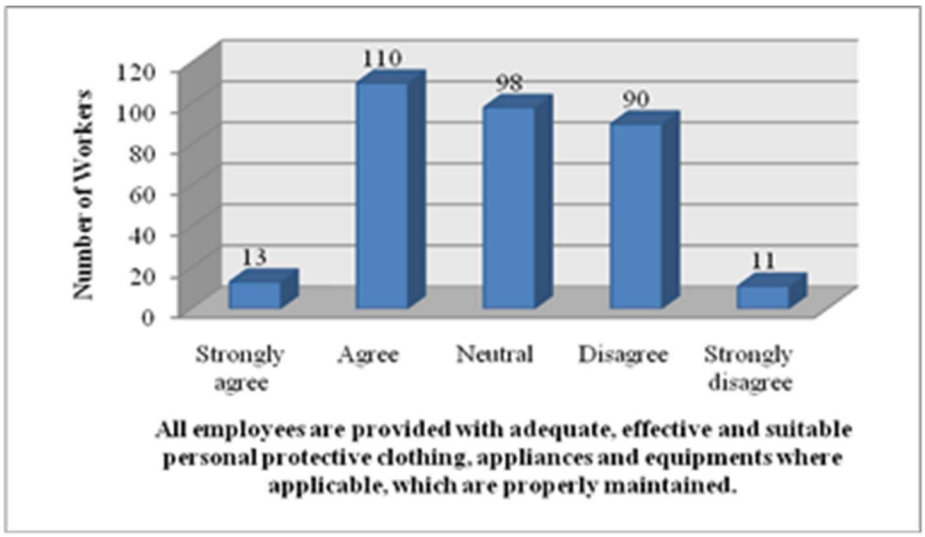

Figure 4: Personal protective clothing, appliances and equipment

3.2.5 Biological and workplace monitoring

Biological and workplace monitoring were carried out periodically as appropriate in very few paint industries. This was evident since majority 236 (73.3%) of the respondents either disagreed or strongly disagreed that the periodic monitoring was carried out at their workplace (Figure 5). The study found out from the interviews and desktop reviews that majority of the paint industries had neither ensured occupational medical examinations of workers nor air quality monitoring are carried out. Moreover, some of the industries that ensured the monitoring did not do so regularly. This means that it was not easy to determine whether workers in the industries were being affected or not, or whether the controls in place were effective or not. From the FGDs, it was agreed that medical examinations should be carried out periodically in order to monitor the health of the workers who are likely to be affected. It was also agreed that air quality monitoring was necessary in order to evaluate the effectiveness of the various risks control measures that had been put in place, and also to form the basis of determining the workers who require medical examinations depending on the exposure.

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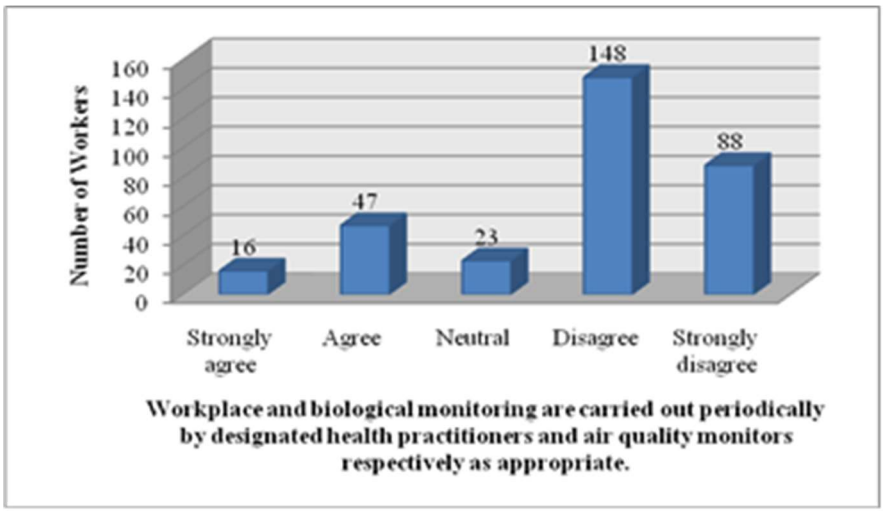

Figure 5: Workplace and biological monitoring

3.2.6 Chemical disposal

The results of the study, Figure 6, shows majority 228 (70.8%) of the respondents confirmed that chemical wastes, including empty chemical containers, were properly disposed-off so that they did not present risks to the workers or the environment. However, the study observed some of the industries disposing some chemical wastes inappropriately by draining into the sewer line. A few of the industries had contracted NEMA authorized waste collectors for collection and appropriate disposal of their wastes.

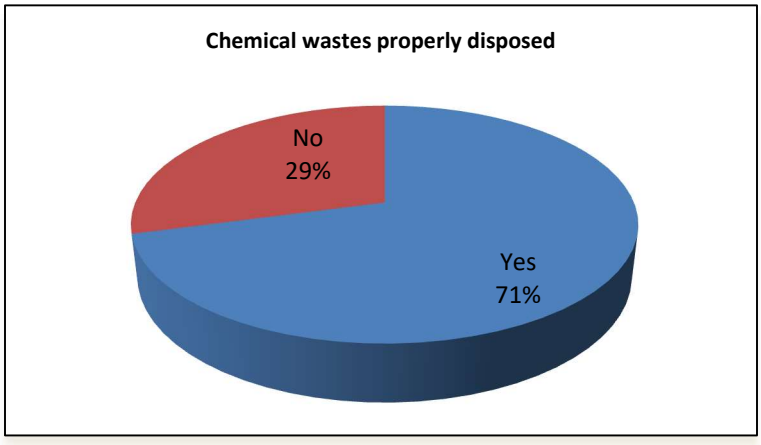

Figure 6: Disposal of chemicals

3.2.7 Transport and transfer of chemicals

Majority 258 (80.1%) of the respondents indicated that appropriate devices such as enclosed systems and pipelines, were not being used in their workplaces to allow the safe transport and transfer of harmful chemicals (Figure 7). This was also observed by the study in most of the paint industries. The study observed that some of the containers used to carry highly flammables were

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not leak proof and most of them were open. Majority of the industries did not use pipeline or enclosed systems to transfer or transport chemicals within the industries, but rather transferred chemicals manually or using forklifts in containers.

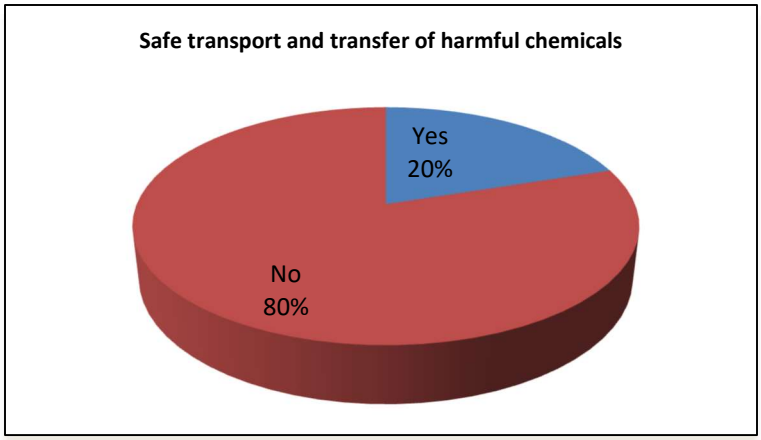

Figure 7: Transport and transfer of chemicals

3.2.8 Coordination of chemical safety

In the study, found out that only a few 4 (20%) of the sampled industries either had specific persons or committees appointed to plan and coordinate activities on chemical safety, figure 8, while the rest of the industries did not. The study found out from the interviews that only 3 (15%) of the sampled industries had OSH personnel while 1 (5%) had appointed the production manager to be coordinating OSH. It therefore means in majority of the industries it was not clear who is responsible of coordination of OSH and by extension chemical safety. This clearly showed that OSH was not regarded as important by most the industries.

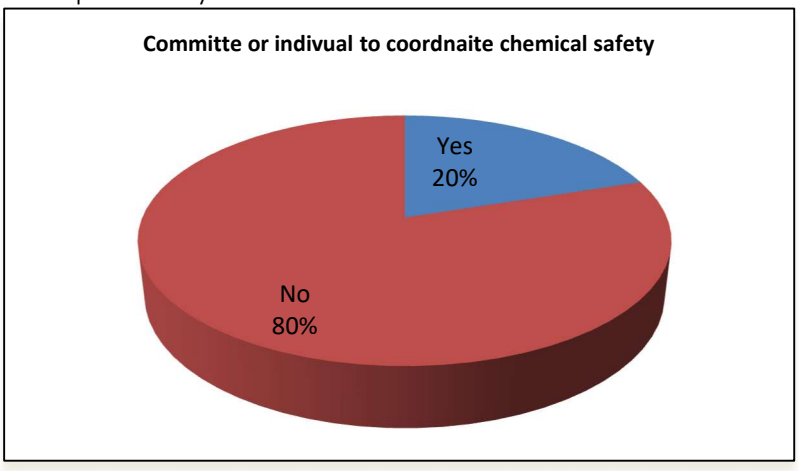

Figure 8: Coordination of chemical safety

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3.2.9 Provision of instructions and supervision

The study also sought to find out whether there was provision of adequate instructions and supervision to ensure the safety and health of workers with respect to chemicals. Figure 9 shows that only a minority 9 (2.8%) and 15 (4.7%) strongly agreed and strongly disagreed respectively. A minority 76 (23.6%) also just disagreed that they were provided with adequate instructions and supervision, while majority 112 (34.8%) and 110 (34.2%) were neutral or disagreed respectively. It can be concluded that majority of workers in paints manufacturing industries either are provided with inadequate instructions and supervision or are not provided at all. However, from the discussions with various groups of the workers, it was concluded that workers were provided with adequate instructions and supervision to ensure productivity and minimal to ensure safety and health. These results show that majority of the factories valued productivity over OSH. This means that they failed to understand that productivity can be enhanced by ensuring OSH.

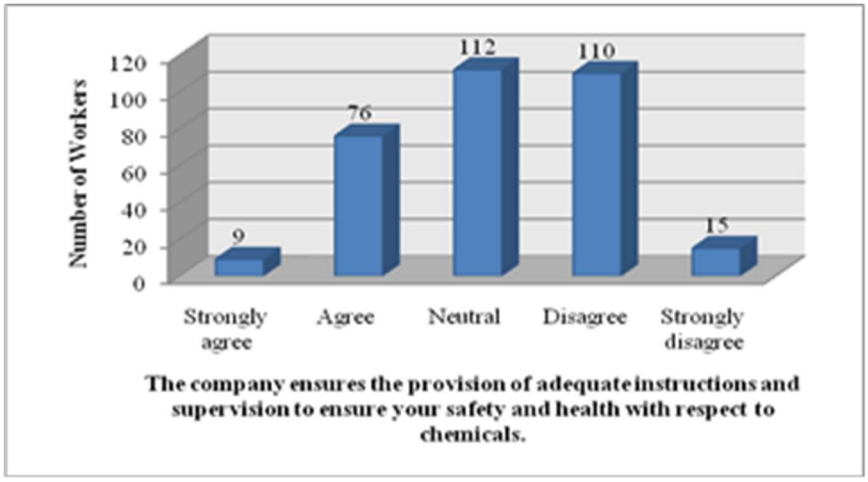

Figure 9: Provision of instructions and supervision

3.2.10 Association between training and provision of instruction and supervision

The research sought to determine whether there was any relationship between training and provision of instructions and supervision. From the findings, there was some slight relationship between training and provision of instructions and supervision. The results indicated that nearly all the respondents who had been trained were provided with instructions and supervision. The results also show that majority of those who had not been trained were not provided with instructions and supervision. Figure 10, 45 (52.9%) of the sampled workers who were trained were provided by adequate instructions and supervision.

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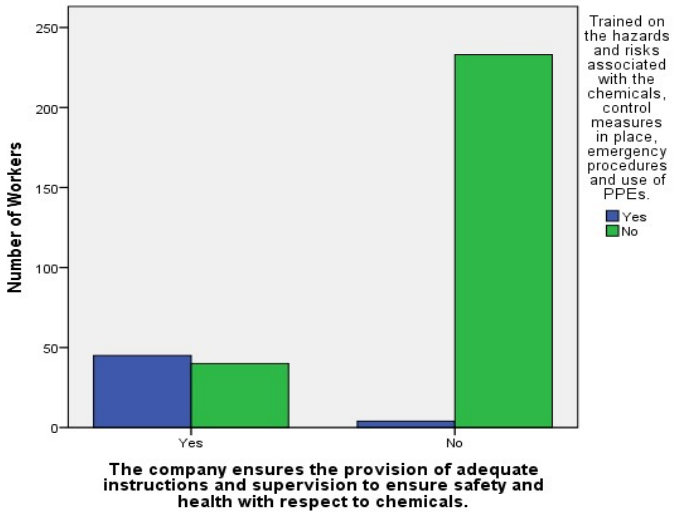

Figure 10: Comparison between training and provision of instructions and supervision

This study agrees with Basiru et al., (2023) study that concluded that there was a lack of adequate work safety practices in the paint factories in Lagos West Senatorial District and there were gross deficiencies in use of PPDs. This study showed that most of the paints factories in Kenya had not provided adequate safety practices and that PPEs were not being used satisfactorily by most of the workers.

This study also agrees with Rikhotso et al., (2022) study that found that the developing countries are faced with more severe and complex problems due to general lack of awareness about the potential hazards of chemicals and lack of proper protective measures.

To test the effectiveness of the control measures the study used a model comparing control measures and their effectiveness as indicated in Table 4. Results in Table 4. Shows the model summary results. The output indicates that the effect of control measures on the OSH for paint manufacturing companies in Kenya is statistically significant, $R^2 = 0.078$ F (1, 319) =21.863, p-value <.05. This shows 7.8% of OSH effectiveness in paint manufacturing industries in Kenya is attributed to control measures in place while the remaining 92.2% can be attributed to other factors not included in the study and the error term.

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Table 4: Model summary of control measures and effective OSH

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Change Statistics				
					R Square Change	F Change	df1	df2	Sig. F Change
1	.286[a]	.082	.078	.41002	.082	21.863	1	319	.000

a. Predictors: (Constant), Control Measures
b. Dependent Variable: Effective OHS

It was the observation of the study that only 3 (15%) of the sampled paints manufacturing industries had adequately controlled risks to safety and health posed by chemicals and hazardous substances compared to 17 (85%) of them who had inadequately controlled risks, Figure 11. The study observed that most of the industries had neither ensured processes involving hazardous substances were carried out in enclosed system so as to prevent any exposure of the workers to the substance, nor ensured such processes were automated or conducted by use of remote-controlled systems. As discussed earlier there were no safe systems of work such as safety policy, safe work procedures and permit to work systems, established and implemented in most of the industries. Majority of workers had not been provided with adequate instructions and supervision to enable them work safely. The study also found out, as discussed earlier, that only a few 3 (15%) of the sampled industries had ensured suitable PPEs were provided and maintained, and that they were being used by employees. However, it was observed that most of the workrooms in majority of the industries were well ventilated which helped reduce the concentration of vapours and fumes from the paints within the work environment. Moreover, the study was able to establish that a few of the industries had substituted some of the more hazardous substances with less hazardous ones for example making water-based paints instead of solvents-based paints. Lead compounds is also being faced out and some of the industries confirmed that they no longer use lead compounds in manufacture of paints.

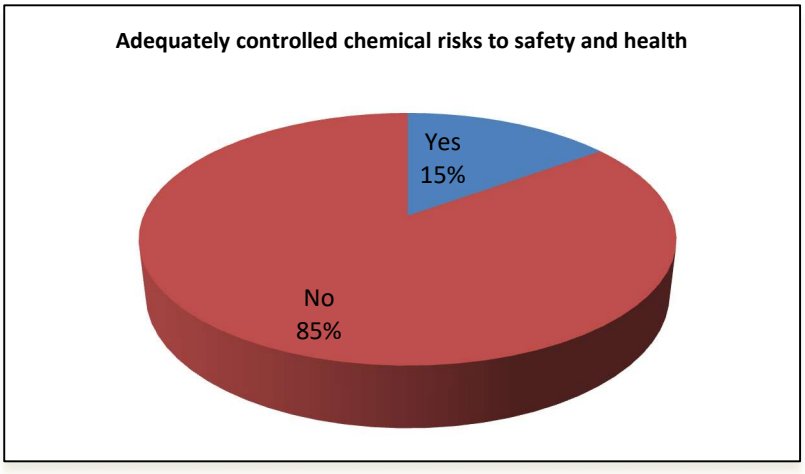

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Figure 11: Control of chemical risks

4.0 Conclusion

From the results, there was clear indication of some measures put in place by both individuals and paint industries. These included safe systems of work, proper storage of chemicals, provision of emergency response and evacuation plans, personal protective equipment, proper disposal, proper transportation/transfer and coordination of chemical controls in some of the factories. However, the general findings are that there were limited controls in place against risks to safety and health in most of the paint manufacturing industries in Nairobi County. The study findings indicated that there was low level of implementation of controls measures against risks to safety and health posed by chemicals.

5.0 Recommendations

From the findings and conclusion of the study, industry players as well as stakeholders in paint manufacturing could therefore use these results while choosing on what controls to apply against risks to safety and health posed by chemicals in the paint manufacturing. Specifically, the study recommends that the manufacturing firms should ensure various controls are put in place, against risks to safety and health posed by chemicals, according to the hierarchy of controls.

6.0 Acknowledgments

6.1 Ethical considerations

Ethics of data collection and analysis, the ethics of responsibility to the society, and the ethics of treatment of participants was ensured in the study. Permission to carry out the study was sought from the Ministry of Labour and Social Protection (MoLSP), National Commission for Science, Technology and Innovation (NACOSTI), JKUAT, and the selected paint manufacturing industries where the study was carried out. Consent was also sought from all participants. The objective of the study was explained to the factory management and the participants in the study. Questionnaires were assigned unique codes and the results of every questionnaire were kept confidentially. Participation in the study was voluntary and the participants were given an option of withdrawing from the study at will.

7.0 References

Ayaga, F., Mburu, C., & Karanja, B. (2024). Assessment of ergonomics hazards and associated health effects in selected food and beverage industries Nairobi Kenya. Journal of Agriculture, Science and Technology, 23(1 (1)), 1-11. https://orcid.org/0000-0002-9738-1131

Bandery Elsayed, N., Mohamed Mohamed, H., & Mohamed Sayed, S. (2024). Occupational Health Hazards among Workers in Chemical Factories. Egyptian Journal of Health Care, 15(2), 881-891. https://ejhc.journals.ekb.eg/article_357829.html

Bartlett, J. E., Kotrlik, J. W., & Chadwick C. Higgins. (2001). Determing appropriate sample size in survey research. *Information Technology, Learning, and Performance Journal*, *19*(1), 43–

ISSN 1561-7645 (online)
doi: 10.4314/jagst.v25i2.6

50. DOI: https://www.opalco.com/wp-content/uploads/2014/10/Reading-Sample-Size1.pdf

Basiru, J. O., Ejiofor, C. L., Onukwulu, E. C., & Attah, R. U. (2023). Corporate health and safety protocols: A conceptual model for ensuring sustainability in global operations. Iconic Research and Engineering Journals, 6(8), 324-343. DOI: https://www.researchgate.net/publication/388418888_Corporate_Health_and_Safety_Protocols_A_Conceptual_Model_for_Ensuring_Sustainability_in_Global_Operations

Han, J. H., Lee, D. H., & Lee, N. R. (2024). A Study on Hazard Classification by Metal Element analysis of Paints Containing Inorganic Pigment. Journal of Korean Society of Occupational and Environmental Hygiene, 34(3), 193-201.

ILO. (2021). Exposure to hazardous A global review resulting health impacts. In *Immigration and Asylum [3 volumes]: From 1900 to the Present [3 volumes]* (Vol. 1). DOI: https://doi.org/10.4337/9781800378841.i.19

Mbuku, A. K. (2024). Management of Health and Safety Risks on Sites During Construction Process: Case Study of Private Developments in Kiambu County, Kenya (Doctoral dissertation, University of Nairobi). DOI: http://erepository.uonbi.ac.ke/handle/11295/167288

Mwai, L., Onyatta, J., & Were, F. H. (2023). Lead content in automotive paints purchased at formal and informal outlets in Kenya. Heliyon, 9(1). DOI: https://www.cell.com/heliyon/fulltext/S2405-8440(23)00038-5

Njogu, P. K., Mburu, C., & Karanja, B. (2019). Role of safety and health awareness in occupational safety and health performance in public health facilities in Machakos County, Kenya. Journal of Health and Environmental Research, 5(1), 1-7. http://www.sciencepg.com/journal/jher doi: 10.11648/j.jher.20190502.14

Nyawira, L., Tsofa, B., Musiega, A., Munywoki, J., Njuguna, R. G., Hanson, K., ... & Barasa, E. (2022). Management of human resources for health: implications for health systems efficiency in Kenya. BMC health services research, 22(1), 1046. DOI: https://link.springer.com/article/10.1186/s12913-022-08432-1

Olufunsho Awodele, T. D. (2014). Occupational Hazards and Safety Measures Amongst the Paint Factory. Safety and Health at Work, 106 - 111.

Rikhotso, O., Morodi, T. J., & Masekameni, D. M. (2022). Occupational health and safety statistics as an indicator of worker physical health in South African industry. International journal of environmental research and public health, 19(3), 1690.DOI: https://www.mdpi.com/1660-4601/19/3/1690

Salari, S., Sadeghi-Yarandi, M., & Golbabaei, F. (2024). An integrated approach to occupational health risk assessment of manufacturing nanomaterials using Pythagorean Fuzzy AHP and Fuzzy Inference System. Scientific Reports, 14(1), 180.DOI: https://www.nature.com/articles/s41598-023-48885-w

Samanta, S., & Gochhayat, J. (2023). Critique on occupational safety and health in construction sector: An Indian perspective. Materials Today: Proceedings, 80, 3016-3021.DOI: https://www.sciencedirect.com/science/article/pii/S2214785321049701

ISSN 1561-7645 (online)
doi: 10.4314/jagst.v25i2.6

Singhal, M., Saxena, M., Nagar, V., Jadhav, E. B., Awasthi, G., Awasthi, K. K., & Sankhla, M. S. (2022). Lead toxicology: Implication of toxicity in pregnancy, infants, and children. International Journal of Medical Toxicology & Legal Medicine, 25(3and4), 21-30.DOI: https://www.indianjournals.com/ijor.aspx?target=ijor:ijmtlm&volume=25&issue=3and4&article=004

Thomas, D., Philip, E., Sindhu, R., Ulaeto, S. B., Pugazhendhi, A., & Awasthi, M. K. (2022). Developments in smart organic coatings for anticorrosion applications: a review. Biomass Conversion and Biorefinery, 12(10), 4683-4699.DOI: https://link.springer.com/article/10.1007/S13399-022-02363-X

WHO 2021: Retrieved on 10.05.2025 from https://www.who.int/health-topics/occupational-health

ISSN 1561-7645 (online)
doi: 10.4314/jagst.v25i2.6