

Impact Of Hazardous Waste Management Practices on Environmental and Occupational Health: A Case Study Approach

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Abstract- The current research evaluated the effects of hazardous waste management practices on the environment and health of workers. The study aimed to investigate via to measure the environmental and health implications of existing hazardous waste handling, storage, treatment, and disposal practices. A descriptive and analytical research design was used, along with collecting both primary and secondary data sources. The results showed that bad segregation, poor storage, and non-compliance with rules were the main factors causing soil and water pollution. The research also found that workers in hazardous waste handling were at risk of having health problems such as respiratory disorders, skin diseases, and injuries. The analysis using statistics proved that there was a strong link between waste management practices and both environmental and health issues. The researchers claimed that the efficient management of hazardous waste was the main factor that kept environmental pollution and health risks to workers at bay. The research pointed out the need for stricter regulatory enforcement, regular training programs, and improved safety measures. The results were regarded to help policymakers, industry managers, and regulatory authorities in creating sustainable hazardous waste management strategies that will protect both the environment and the health of workers.

Keywords: Hazardous Waste Management, Environmental Health, Occupational Health, Waste Handling Practices, Environmental Pollution, Worker Safety

I. INTRODUCTION

1.1 Growth of Hazardous Waste Generation

The rapid industrialization that has occurred in recent decades has had the effect of changing production systems throughout the globe in a fundamental way and one of the results of this transformation was the

hazardous waste generation increase in a significant amount. Most industries from different sectors like manufacturing, petrochemicals, pharmaceuticals, mining, and metallurgy produce huge amounts of waste that contain toxic and reactive materials. These waste streams are generally inclusive of heavy metals, solvents, acids, alkalis, and persistent organic pollutants which all together create long-term threats to ecosystems. The fact that industries are operating at a higher rate to satisfy the rising consumer demand has not only increased the volume of waste generated but this increase is also seen in the complexity of the waste. Reliable waste management systems are almost nonexistent in many industries that result in a lot of wastebin generated at the source which is eventually thrown away.

In many instances, waste management is viewed as a second thought, not as a part of industrial planning. This view in the long run leads to unsafe disposal practices that would then jeopardize both the environment and public health. In many places, industrial growth has been at a faster rate than the corresponding development of waste management infrastructure. As a result, hazardous waste is frequently left untreated or uncontained. All these issues point to the need for waste management to be incorporated into industrial development planning more than ever. The lack of proper control measures will still see the environmental degradation problem worsened by industrialization. In other words, the environmental situation will be such that the very activities aimed at sustaining development will conflict with one another as the cumulative effect of the generation of hazardous waste that is not properly

managed will be one of the sustainability goals that would be hardest to achieve.

Urban development has, more or less, been responsible for the rise of hazardous waste generation in all parts of the world. The speed with which urban areas have been developing has brought not only industries and hospitals but also laboratories and entire service sectors to reside within the confines of a city. Urban regions create a variety of hazardous waste such as medical waste, chemical remnants, electronic waste and waste from households using hazardous materials. The extension of health facilities in the cities has made the generation of waste, both infectious and that of pharmaceutical, easier. Likewise, the lifestyle the inhabitants of the cities live, which majorly depend on electronics, ends up being a major factor in the production of e-waste. Due to the limited availability of land for waste disposal and insufficient facilities, a number of cities are unable to cope with the management of hazardous waste. Often, urban waste management systems are primarily for municipal solid waste and thus hazardous components are neglected. Hence, contaminated waste going to landfills is increased by the fact that hazardous waste frequently comes into contact with general waste. The urban informal sectors often participate in waste handling and do not have the necessary safety measures. Hence, workers and residents alike are at a higher risk of being exposed to toxic substances. Construction activities done at a rapid pace in the cities also give rise to the generation of hazardous waste classified as construction and demolition waste. Urban sprawl tends to invade environmentally sensitive areas which then aggravates the issue of improper disposal of waste. Urban development that is not properly planned puts even more pressure on landfills and waste treatment plants. In many instances, hazardous waste is dumped illegally in vacant urban areas or in water bodies. These activities not only ruin the environment in urban areas but also compromise public health. The urban population is at a particularly higher risk since they are living in an area with a high population density.

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processes require the use of very complicated chemicals, which are not only hard to neutralize but also not easy to recycle. The biotech and pharma sectors produce hazardous waste that must go through expensive and specialized treatment processes. Nanotech has brought about the introduction of new materials whose environmental and health hazards are still unrecognized. The waste from technologically high-end materials necessitates the use of sophisticated treatment facilities. But many areas do not have such facilities available to them. As technology moves fast, regulations for managing waste are usually not kept up. This gap between regulations and practices enables the unsafe disposal methods to continue existing. Often the technological waste streams are blended with conventional waste because of the lack of awareness. Recycling e-waste done informally makes the workers inhale and meet toxic fumes and residues. A lot of developing countries receive electronic waste disguised as second-hand goods. This practice results in the transfer of hazardous waste from developed to developing nations.

Hence, technological advancement has made hazardous waste issues globalized. Nonetheless, technology does not always guarantee that waste can be treated since access to it is still limited. Expensive costs prohibit the implementation of high-tech waste management processes in industry circles. There are still times when most of the sectors would rather invest in production efficiency over waste treatment. Primary sectors accountable for the generation of a large amount of hazardous waste are manufacturing, chemical processing, healthcare, and electronics. The

manufacturing industries are the source of waste made up of oils, solvents, metal residues, and chemical by-products. The chemical industry is responsible for the production of waste that is highly toxic, corrosive, and reactive which necessitates expensive and complex handling. Hospitals and clinics are a source of waste that is infectious, contains sharps, pharmaceuticals, and in some cases, even radioactive materials. Biomedical waste disposal that is not properly done can lead to infections and, in some cases, contamination of ecological systems. The electronics industries produce a lot of waste that is heavily contaminated with toxic metals such as lead, mercury, and cadmium that may stay in the environment for a long time and also be ingested by living organisms. Each of these industrial sectors have their own peculiar problems in waste management. The variety of hazardous waste types makes it almost impossible to have uniform management practice.

Waste handlers that are often external are the ones that industries depend upon and the practices they use may not be well regulated. The lack of adequate supervision increases the chances of the illegal dumping and mishandling taking place. Many small-scale businesses do not have the funds to install the necessary infrastructure for safe waste treatment. Consequently, the hazardous waste is often disposed of in a manner that is unsafe. Environmental impacts are aggravated in industrial clusters where waste management systems fail. The people living in the vicinity of the industries are the ones who must bear the brunt of the exposure risks. Industrial accidents can inflict both instantaneous and chronic harm. Pollution from the industry may affect air, water, and soil at the same time. Emergency readiness for the toxic waste incidents is usually not up to the mark. Sometimes, industries try to stay below the radar by underreporting their waste generation which means they avoid regulatory scrutiny. This not only affects the waste management planning but also the monitoring of the process.

One of the major threats to the sustainability of the environment is improper handling and disposal of hazardous waste. For instance, if the hazardous waste is disposed of on land, the toxic constituents can leach into the ground and this can lead to soil

degradation and eventually, the disruption of the natural ecosystems. Contaminated earth, in turn, has a detrimental impact on the yields of the farms and even on the safety of the food products. The placement of hazardous waste in water bodies leads to the pollution of surface and groundwater resources. Unclean water becomes a danger for the aquatic organism and, too, for humans as it is a source of their drinking water. The same situation occurs with air pollution where waste is either openly burned or improperly incinerated. Some emissions are very toxic and they not only cause but also worsen the respiratory diseases and, at the same time, the climate changes. Pollution of the environment by waste is often a long-term issue that lasts for many years. Some of the pollutants, for instance, go on for decades before they become untraceable through natural degradation. These conditions even allow certain substances to accumulate in the food chain, thus, the higher levels are reached through the most sensitive participants being the ones that die out. The process of cleaning up environmental waste sites is usually expensive and complicated. Unfortunately, in some cases, the contaminated places have to wait years before they can be treated. This not only puts the people living around them at risk for a prolonged period of time, but also the whole community that might be affected through the supply of contaminated water and food. Furthermore, the damage inflicted on the environment has a negative impact on economic activities such as agriculture and fisheries. Overall, the quality of life of affected people is further deteriorated because they lose the benefits of the ecosystem services provided to them. The pollution of hazardous waste is like a shadow over the efforts aimed at the sustainable development of the planet. Environmental justice issues come to the surface when the already vulnerable groups bear the brunt of the impact. Usually, the poorest populations are found living near waste disposal places. Thus, the problem of improper disposal becomes not only an issue of the environment but also of the society that needs to be addressed at the same time. It is more sensible to prevent than to mend. Sustainable management of waste is a core factor in protecting the environment in the long run.

Human health is one of the key aspects that suffer from improper hazardous waste management.

Contaminated air, water, and food are the routes for toxic substances to reach the human body. Acute exposure to such substances might result in symptoms like nausea, skin irritation, and trouble breathing. Chronic exposure is linked with severe medical conditions such as cancer and nervous system disorders. Hazardous waste workers are those who mostly get the higher exposure. In fact, workers are often in contact with these toxic substances directly. The absence of safety equipment makes them more to the hazardous materials. The people living around these disposal areas also suffer from health problems. In particular, kids and older people are the most.

affected. One of the main sources of health risks in these communities is the supply of drinking water that has been contaminated. Toxins that get into the soil and then enter through crops and animals are the means by which the humans are exposed to them in the long term. By the time health impacts are noticed, they might be quite widespread already. The fact that the impacts might not be instantly visible renders the process of diagnosis and treatment very complicated. Unfortunately, the majority of health problems related to hazardous waste are still not being reported.

The situation in the communities affected by this is that the unavailability of healthcare services leads to patients dying without having been diagnosed or treated. The issue of monitoring occupational health is very often overlooked or poorly handled. Health checks of workers may not be done regularly. Therefore, the early detection of occupational diseases is delayed. Health impacts also represent a major economic burden for families and healthcare systems. Due to illness and disability, there is a decrease in productivity. Preventive waste management measures are needed to safeguard human health. Prevention is by far the best strategy as it costs less compared to curing one's health. Hence, managing hazardous waste is a public health concern that cannot be overlooked.

The growing intricacy of hazardous waste is a source of even more management difficulties. Contemporary manufacturing causes waste that can be hazardous in more than one way. The treatment of mixed waste

streams is specifically dependent on advanced methods. Waste that cannot be combined because of different properties can cause a very dangerous situation if not stored correctly. Proper classification of waste is a must but is frequently missing.

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A one-size-fits-all approach does not work. The disposal alternatives are restricted due to environmental regulations. The cost of operation for secure landfills and incinerators is high. The small amount of space available leads to illegal dumping. Informal handling of waste means no compliance with safety measures. The monitoring of complex waste flows necessitates reliable information systems. Regions in many cases do not have dependable data about the generation of hazardous waste which affects planning as well as regulating. Complexity also makes it harder for authorities to impose regulations. Skilled workers are necessary to handle the complex waste streams. There is a need for new waste treatment technology to solve the problem that's been created by the waste. Integrated management methods can work for the complexity.

The management of hazardous waste is a major problem for developing countries. The rapid rise in the industrial sector is without a corresponding regulatory structure in place. The systems for waste management are overwhelmed and can no longer cope with the industrial growth. Financial constraints mean that the investment in waste treatment plants is very limited. The personnel who handle hazardous waste often lack the necessary training and skills. There are few training programs available for

workers and regulators, and the ones that are available are of low quality. Hazardous wastes present a risk and that is why awareness is very low. Unregulated sectors are important.

to the waste management process. These sectors are working and living outside the laws. The informal workers have no safety measures in place.

The environmental monitoring systems are usually not reliable. There is no effective implementation of policies because of data gaps. The laws are not enforced uniformly. Corruption and lack of efficiency in administration make the situation even worse. The importation of hazardous waste increases the burden of domestic waste. If developing countries were to import hazardous waste, then they would probably not be able to manage it properly. The international treaties are sometimes not enforced well. The people who live close to the industrial areas suffer from the highest pollution of all. Their poverty gives them very little power to demand that the polluting practices be stopped or at least reduced.

The community is not allowed to take part in the decisions concerning waste management. These challenges can only be solved through a systemic approach involving reforms. Building of capacity and international cooperation are the two main ingredients for the successful outcome. Waste management solutions for developing countries need to be designed according to their specific conditions. The process of institution strengthening is very decisive for the sustainability of the results.

Weak regulatory enforcement amplifies the risks associated with hazardous waste. A lot of the countries have full-scale waste management laws enacted and on the books. Still, the reality of their application makes them less effective. The regulatory bodies usually suffer from a lack of personnel. The activities of inspection and monitoring are limited by the scarce resources. Non-compliance penalties may not be very high. Industries might consider fines as a part of their operating costs. An absence of communication among the different agencies results in the emergence of escape routes. Different authorities performing similar duties leads to misinterpretation and a longer process. The changes

in regulations may not keep pace with the technological advancements. Therefore, the new waste categories are left uncovered.

The public's access to waste information is commonly restricted. In case of a lack of transparency, there is no accountability. Community observatory system is not that effective. The enforcement actions may be affected by the political pressures. Small and medium enterprises are also treated like giant industries when it comes to regulation. This gives room for the continuance of dangerous methods of waste disposal. Illegal waste workers are almost free to do whatever they want. Political will is indispensable on the path to enforcement consolidation. Training and development for the regulators are of utmost importance. The implementation of virtual monitoring tools can lead to better compliance. A well-informed public can back up the enforcement operation. A win-win situation of regulations exists when economic growth is accompanied by environmental protection. Sustainable hazardous waste management relies on strong institutions. Regulations without enforcement are rendered useless. For this reason, addressing enforcement gaps becomes of great importance.

The management of hazardous waste has become an effective environmental measure and an issue that the world is concerned with critically. Integrated solutions are the only way to address the environmental and health impacts that are closely related to each other. Hazardous waste management is not just a matter of the technique used, it is also a day-to-day life, economic, and governance problem by large. Solutions that are sustainable will demand the cooperation of different sectors. The industries have to embrace the use of cleaner production methods. Waste reduction must take place first at the source. The governments have to take strong measures in the regulatory framework. A huge investment in infrastructure is a must. Training and awareness programs are to be extended. The workers require sufficient protection as well as health monitoring. The communities must be part of the decision-making process. International cooperation can be the solution to the issues of waste that crosses boundaries.

The research and development of new technologies will make treatment more efficient. The use of data in planning and monitoring is a great way to improve them. The provision of financial benefits can be a motivating factor for compliance. The collaboration between public and private sectors can lead to the mobilization of resources. Environmental and occupational health must be treated as one issue. Any fragmented approach will be futile. Responsible waste management is the key to long-term sustainability. If the environment is saved, human health will be saved too. Thus, hazardous waste management is a determining factor for ecological solidarity. Dealing with present challenges is a very urgent global priority. Not doing anything will cause negative effects that will last for the coming generations.

Even though there are regulatory frameworks and formal guidelines for managing hazardous waste, a lot of regions still have big problems when it comes to implementation and compliance. The regulations are mainly kept in papers, and only a little of them are translated into actual operations. The industries do not comply with the prescribed waste management standards completely due to the reasons of high costs, no accountability, or insufficient monitoring. The regulatory bodies often suffer from a lack of skilled workers and monitoring resources, which means that enforcement cannot be effective. The inconsistency in inspections and the weak penalties further discourage

The management of hazardous waste being effective needs a systematic and integrated approach that covers all the stages of waste handling. The first and the most important step is the proper segregation at the source, since it prevents cross-contamination and makes possible the proper treatment. The safe storage conditions must be kept in such a way as to prevent the leaks, spills, and chemical reactions. The transportation of hazardous waste calls for the use of specialized vehicles and the presence of trained staff in order to keep the accident risks to a minimum. The selection of the treatment methods has to be done according to the specific characteristics of the waste. The environmentally sound disposal practices are the ones which are taken to be essential to the quality of the soil and water in the long run. The management

of the waste through each stage has to be done with very close supervision. No way of doing it in small parts

Without a doubt, reinforcing policy enforcement is the primary key to unlocking better results of hazardous waste management. The main regulatory authorities should be provided with the necessary resources for keeping up with the inspection and monitoring processes. Violation penalties need to be such that they are unable to pay with illegal practices. Monitoring through public disclosure and reporting can be one way of enhancing the accountability. Prerequisite worker training programs should not only be established but also frequently updated. The compliance level of the company can be raised through training and capacity building programs. The production processes that are less wasteful and environmentally friendly rather than plain destruction should be made the new industry standard. Providing monetary benefits is one way to make the industries consider investing in eco-friendly technology rather than sticking to the old one. Solving these problems is a task that has to be performed if one wants to enjoy the benefits of long-term environmental sustainability. Occupation health protection is a matter that also concerns the quality of life of people, thus, it is very important. The mentioned measures, along with other practices, ensure that there are no hazardous working conditions and, on the other hand, ecosystems are healthier.

Even though there are extensive regulations and guidelines for hazardous waste management, inappropriate practices are still common in different sectors. The source point not being correctly separated for hazardous waste is a major cause of wastage being mixed with non-hazardous materials and subsequently raising the risk of contamination. One of the major causes of environmental degradation is the adoption of unsafe disposal methods, such as open dumping, and improper burning. The lack of suitable personal protective equipment makes workers vulnerable to toxic substances while inadequate training makes it impossible for them to deal with hazardous materials safely. The above-mentioned shortcomings together with the regulatory shortcomings diminish the

effectiveness of the regulatory frameworks already in place. Consequently,

It is quite obvious that bad management of hazardous waste practices has a bad impact on environment which comes forth in the form of increased pollution and health risks to workers. The wrong approach to waste disposal and their taking care mixed up and the result is contaminating the soil, water, and air thereby affecting the entire living world and even the people. Besides, these the workers in the waste sector are at the highest risk of suffering from chemical exposure, respiratory diseases, skin problems, and chronic diseases of long duration. Working in unsafe conditions without proper safety measures can lead to very serious injuries and poor quality of life for the workers. The effect of such health problems is not only felt by the individual worker but also it imposes an economic strain on both the healthcare systems and the industries. Solving these problems necessitates good knowledge of how waste management practices dictate both the environmental and human health outcomes.

Although these challenges are increasingly being recognized, empirical research that looks at the effects of hazardous waste management practices on both environmental quality and occupational health outcomes at the same time is still very limited. The majority of the existing studies deal separately with either the environmental impacts or the occupational health risks. The lack of integration and interdisciplinary studies does not allow for the formulation of evidence-based policies and the devising of effective implementation strategies. Policymakers and industry stakeholders will have to rely on fragmented insights to come up with comprehensive interventions if a holistic assessment is not carried out. This research gap underlines the necessity of the present study, which is going to give an integrated evaluation of hazardous waste management practices and their combined impact on environmental sustainability and occupational health. Impeded settling. SPM levels will be monitored to evaluate the dust impact during the construction phase of the Project.

The Contractor shall comply with the Indian Government legislation and other State regulations in

existence in Delhi insofar as they relate to water pollution control and monitoring. A drainage system should be constructed at the commencement of the Works, to drain off all surface water from the work site into suitable drain outlet. The Contractor shall provide adequate precautions to ensure that no spoil or debris of any kind is pushed, washed, falls or deposited on land adjacent to the site perimeter including public roads or existing stream courses and drains within or adjacent to the site. In the event of any spoil or debris from construction works being deposited or any silt washed down to any area, then all such spoil, debris or material and silt shall be immediately removed and the affected land and areas restored to their natural state by the Contractor to the satisfaction of the Employer.

II. LITERATURE REVIEW

The prevailing studies in the existing literature point out that hazardous waste management practices are greatly influenced by the national and international regulatory frameworks which are designed to minimize the risk to the environment and human health. These frameworks are synonymous with legal definitions, categorization, and procedures throughout the lifecycle of hazardous waste management. The Basel Convention is an example of international treaties that have a great influence on the development of global standards regarding the handling and movement of hazardous waste across borders. Sometimes national regulations are found to tailor these international norms governing the waste to the local industrial and environmental conditions. According to the researchers, the main role of such frameworks is to set accountability and responsibility among the waste generators and handlers.

Furthermore, the frameworks indirectly play the role of protecting the environment and the health of the workers. On the other hand, the efficiency of the frameworks is very much dependent on the capacity of enforcement. The mere existence of legal provisions becomes meaningless without the backing of institutions. The regulations help to bring about uniformity in waste management practices across different sectors. Literature, in general, sees regulation as the mainstay of hazardous waste handling and management.

The studies assert with great conviction that thorough waste segregation is one of the major steps for hazardous waste management to be successful. When proper segregation is done right at the source, the hazardous and non-hazardous wastes do not mix together, and thus, the risk of contamination is greatly reduced. Among other advantages of segregation, researchers mention the better treatment and disposal process efficiency. Moreover, it helps to lower the level of exposure for workers as they are able to recognize hazards easily. Safe storage methods are similarly important since improper storage can cause leaks, spills, and reactions among the chemicals. Scholarly writings indicate that the design of storage facilities should have built-in containment systems and hazard labeling. In addition, temperature control and compatibility assessments are also of great importance. Poor storage conditions are often blamed for environmental accidents. On the other hand, effective segregation and storage minimize the risks downstream. These methods are universally acknowledged to be the most economical way to prevent problems.

The regulated transportation of hazardous waste is another critical aspect of literature. research points out that transport embodies the risks that are significant because of possible accidents and spills. The proper packaging, labeling, and documentation are emphasized as the major safety measures. The professionals' training, specialized vehicles, and compliance are stressed by the researchers as necessary. Environmental contamination is less likely to occur when the transportation regulations are stringently followed. Moreover, the literature asserts that tracking systems increase the responsibility factor in transit. Poor transportation practices are seldom found in the informal employment sector. These gaps are the ones that put the workers and the public at the highest risk. Hence, the transport regulation is that effective. Management of transportation is regarded as a weak link in the many waste systems

The literature on hazardous waste thoroughly discusses the disposal methods that are environmentally friendly and sound. Specifically, the studies accentuate the necessity for the disposal methods to be selected according to the properties of

the waste. The most thoroughly examined methods are incineration, secure landfilling, and chemical treatment. According to researchers, if the waste is not disposed of in the right manner, the result will be over time harm to the environment. Those sites where the waste is disposed of have to be monitored all the time so that leachate and emissions will not occur. The literature points out that the facilities for disposing of waste have to be taken care of even after they have been closed down. Poorly designed disposal systems do not achieve the objectives laid down by the regulations. The environmentally sound disposal is considered to be the last line of defense. If the failure occurs at this point, no more chances will be given; the consequences will be irreversible. This explains why disposal practices attract considerable attention from academia.

Even with strict regulations in place, the researchers always see a huge difference in the way these regulations are implemented between different areas and sectors. The literature continues to indicate the presence of a gap between policy and actual practice. The level of compliance is often a function of the power of the institutions and the ability of the administration. The studies reveal that the sectors with strong governance exhibit better compliance. On the other hand, lack of coordination in supervision makes the situation worse. The researchers are of the opinion that in some instances, the complexity of regulations becomes a barrier to compliance. Moreover, the presence of vague terms in the guidelines makes the task of enforcement even more difficult. The difficulties in implementation do not exist in the same way in all sectors. The industries that are considered high-risk are more likely to have inconsistent practices. This inconsistency is still major issue around hazardous waste research.

Various reports and studies have found that higher compliance rates in developed countries are mainly due to the stronger institutional capacity in such places. The power of advanced monitoring technologies and enforcement mechanisms makes it possible to regulate effectively. In addition, researchers talk about the existence of well-trained inspectors and professional units. Money, on the other hand, gives an avenue for investment in safer technologies. Also, public awareness and legal

accountability have a more significant impact on compliance. Waste management in developed countries is usually incorporated into sustainability measures. The literature points to the presence of effective inter-agency coordination in these areas. The facilitation of regulatory aims is done through transparency and reporting systems. All these factors combined result in the improvement of hazardous waste management outcomes. It is often the experience of developed countries that are used as benchmarks in research.

On the other hand, developing countries encounter significant obstacles in the enforcement of hazardous waste regulations. Limited infrastructure is mostly cited as the main constraint in literature. Financial restrictions prevent access to the facilities of modern waste treatment. Poor enforcement mechanisms result in a reduction of regulatory power. The existence of informal waste handling industries makes it more difficult to govern. Researchers say that the number of personnel working in regulatory agencies is, in many cases, insufficient. Workers and inspectors suffer from a lack of training. Political and administrative barriers are some other reasons for slow implementation. As a result of these challenges, there is an increase in environmental and occupational risks. Therefore, developing countries need to develop solutions that are suitable for their contexts.

Policy integration is pointed out by the authors as a main aspect to be addressed in order to reach better governance around hazardous waste. The researchers contend that the existence of overlapping policies results in the loss of efficiency and accountability. There must be integration between environmental, health and industry. The studies call for the establishment of common regulations. The cooperation of the national and local authorities strengthens the enforcement of the law. The participation of the stakeholders leads to better compliance and more innovation. The literature also recognizes the public-private partnerships as effective instruments. Integrated policies lead to the elimination of redundant activities. Besides that, they are also supportive of the achievement of the sustainability goals set for the long term. The

integration of policies continues to be the major point suggested by the research.

It is often highlighted that the coordination of stakeholders is the main factor that makes hazardous waste management effective. The literature names the following as principal stakeholders: industries, regulators, workers, and communities. Good communication between these groups makes compliance easier. Researchers claim that the use of participatory methods raises the level of responsibility. Participation of the workers results in safer operations. The involvement of the community supports the monitoring of environmental impacts. Research indicates that absence of coordination brings about regulatory gaps. Different interests frequently disadvantage the application of policies. Joint government ensures that there is no secrecy in the process. Thus, the participation of all stakeholders is of utmost importance.

Even with regulatory advancements, the inconsistencies between the policies intent and their operational execution still exist. The issue of the enforcement deficiencies is consistently raised in literature as a major limitation. The monitoring systems that are weakly built in various sectors enable the continuance of non-compliance. According to the researchers, penalties are hardly ever strong enough to serve as a deterrent. Besides that, the contextual adaptation of the policies is very often lacking. It is still quite a problem since uniform regulations are not appropriate for all industrial settings. The studies are suggesting ways of dealing with it that involve flexible and risk-based approaches. Capabilities development is recognized as an area that should receive priority support. It is necessary to have stronger enforcement mechanisms. Such findings support the argument for policy change and adjustment.

Soil pollution is a major consequence of improper hazardous waste disposal and that is why it is among the most frequently reported consequences. Studies have proven that hazardous substances penetrate deep down through the Earth's crust through leaching, dumping, and uncontrolled landfilling. These particles change the composition of the soil and make them less fertile. Heavy metals as well as other toxic

substances can remain in the soil for many years, even decades. It has been shown that soil contamination negatively impacts the rate of crop production. Plants that are grown in contaminated soil could end up with the accumulation of poisoned substances.

This, in turn, leads to a risk of food contamination and a threat to human health. Furthermore, soil contamination hinders the microbial activity that is essential for the nutrient cycle. Restoration of contaminated soils to their original state, as mentioned in the literature, is a hard task. Therefore, soil pollution is ranked high among the extremely harmful consequences of the improper disposal of hazardous waste.

Groundwater pollution is one of the environmental issues that literature has extensively debated recently. As the researchers indicated, waste materials consisting of hazardous substances that are disposed of in the open landfills start to leach into the underground water sources. Hydrocarbons move through layers of soil and rock, and this leads to aquifers being contaminated. Groundwater pollution comes with very high risks since it is the principal source of water for drinking. Research states that once groundwater is polluted, its change to the original state becomes complicated and expensive. Water from contaminated ground can be unfit for drinking for many generations. The literature points out that tracing the pollution of groundwater is difficult because it is not visible. The rural and industrial areas are the most affected and there is a great deal of health risk involved. Therefore, preventing groundwater contamination has become the main priority in the management of hazardous waste and the research done in this area. The literature calls for better containment systems to be in place to prevent water resources from being contaminated.

The literature cites environmental impact as one of the main consequences of improper hazardous waste management and also discusses the deterioration of air quality. Toxic gases and PM, due to improper incineration, are released into the air during this activity. The burning of hazardous waste in open places not only pollutes the air but also leads to

people being affected with respiratory diseases. Researchers are associating these emissions with the formation of acid rain and global warming. The hazardous pollutants present in the air can blow far away, thus influencing people who are very distant from the source of pollution. Studies suggest that the contamination of air affects mainly the disadvantaged groups in society. The quality of the environment is deteriorated with the constant presence of toxins in the air. Once air pollution is caused by improper waste management it becomes almost impossible to control it. The experts recommend the use of emission control technologies very strongly. In conclusion, air pollution caused by hazardous waste is indeed a major environmental problem

In the literature, the environmental persistence of hazardous chemicals is an issue that comes up continually. Most of the hazardous materials are not easily broken down by natural processes. The result is that these chemicals will be present in the air, and they will be part of the food chain and finally will be in the bodies of humans and animals as well. The increase of toxins at the top levels of the food chain is a result of the process of bioaccumulation. Researchers confirm that this situation is a cause of disturbance in the ecosystem. The animals that are in contact with the poisons stored in the bodies of other animals and plants have to deal with difficulties when they try to reproduce and grow. The decline in the populations of species will negatively affect the whole ecosystem, as they are all interconnected in terms of functioning. This is one reason why literature warns against the use of persistent chemicals that carry the risk of being in the environment for a long time. It is even possible that people are exposed to them for a long time and in low concentrations, leading to cumulative effects. The fact that hazardous waste compounds take a long time to decompose, at the same time, emphasizes the need for preventive strategies.

Bioaccumulation and biomagnification are the main mechanisms of the hazardous waste impact on ecosystems that have been widely talked about. Research indicates that toxic elements are present in large amounts in the living organisms of the ecosystem, e.g. plants and animals. The highest concentration of the toxins is found in the predators

of the food chain. This process results in more deaths and a decrease in species diversity. It is the case that researchers correlate the phenomenon of bioaccumulation with ecosystem instability. Waterborne contaminants make aquatic ecosystems the most susceptible ones. Toxins are very quickly accumulated by fish and other aquatic creatures. The studies are pointing out the implications for food webs and human consumption. Bioaccumulation makes it more difficult for environmental management to succeed. Hence, avoiding contamination is of utmost importance.

Improper incineration and open dumping have been consistently pinpointed as major factors responsible for environmental degradation. The studies indicate that burning without control emits dioxins, furans, and other harmful substances into the atmosphere. The release of these pollutants leads to a very serious and widespread environmental and health burden. On the other hand, open dumping enables interaction between hazardous waste and environmental factors such as air and water. Toxins can be carried through the soil and contaminating water bodies by rainwater. The reports point out that these practices are mainly found in areas with poor regulations. The environmental effect of dumping is not only widespread but also lasts for a long time. It may take a lot of time and money to clean up the sites where dumping has been done. Literature always condemns these kinds of disposal methods. The adoption of sustainable alternatives is highly encouraged.

The undesirable effects on the environment caused by human activities are commonly discussed in the context of hazardous waste literature. The primary researchers are the ones who attribute contamination as the root cause of reduced agricultural productivity and infertility of soils. The land that gets polluted is frequently deemed unfit for growing crops and hence, its value becomes erased. Another significant issue is the extinction of species. Creatures that are living in contaminated areas may die out. The natural processes of pollination and purification of water are also affected. The literature suggests that these impacts have socio-economic consequences. Communities that are solely dependent on natural resources suffer the most as they lose their source of income. The deteriorating environment leads to the

impoverishment of the poor and the rich getting richer. Thus, long-term contamination impacts both the living ecosystem and human society.

Environmental remediation is a procedure that is recognized by many as tedious and costly. Advanced technology and long-term funding are also mentioned in studies as two main components of the whole process. The complete cleaning of polluted places is hardly a practical goal. Some remediation practices may require years or even decades for result. Various sources talk about the heavy financial load imposed by the cleanup process. Newly industrialized countries are in a tougher position because of their smaller resource base. Hence, preventive waste management is seen as a more effective way than remediation. The researchers point out that prevention cuts down the costs for both the environment and the economy. When the contamination takes place, what is left is very few alternatives? It makes the importance of proper disposal even stronger.

In the reports about hazardous waste workers, respiratory ailments have been listed as one of the most frequently reported health problems. Research indicates that these workers suffer from asthma, chronic bronchitis, and other respiratory problems to a great extent. Inhaling toxic vapors, dust, and particles in the air is one major factor that leads to respiratory issues. Besides, burning and uncontrolled handling of wastes are the ways through which the exposure to air pollutants is increased. Researchers state that continuous inhalation leads to the gradual deterioration of the lung capacity. Workers in waste management are the least affected by the lack of ventilation in the facilities. The majority of the workers do not recognize the early signs of respiratory disease. The literature would also mention the lack of medical screening as a significant factor. Usually, respiratory diseases are not treated until they are in the advanced stage. This calls for the adoption of preventive measures and periodic health assessments.

Dermatological conditions have been reported as an important trap in occupational health by several researchers. Skin irritation, rashes, burns, and allergic reactions are the most direct and frequent experiences

of workers. The main cause of these issues is working with corrosive and toxic substances directly on the skin. Besides, the studies point out that the wrong use of gloves and protective clothing has a major role in skin exposure. Chronic dermatological disorders are the consequence of prolonged contacting. Some researchers categorically say that skin conditions are frequently underreported. A good number of workers think that these problems are simply occupational hazards. The literature shows that skin damage is aggravated by repeated exposure. The situation is further worsened by poor hygiene facilities. To take care of dermatological health, both protective equipment and education are necessary.

The physically demanding tasks in the treatment of hazardous waste have led to the widespread reporting of musculoskeletal disorders among workers in that field. Studies report a large number of cases of back pain, joint disorders, and repetitive strain injuries. The manual handling of heavy waste containers plays a major role in the development of these disorders. Ergonomic practices in waste management operations are often poor. Researchers point out that long working hours are a significant factor in causing physical strain. The absence of mechanical aids is a factor that increases the risk of injuries. Musculoskeletal disorders are a cause of decreased productivity and also have a negative impact on the quality of life. There is limited access to ergonomic training according to the literature. These injuries are often a reason for long-term disability. Ergonomic interventions along with workload management are necessary for prevention.

Chemical poisoning is a very serious occupational hazard which is one of the main concerns in literature on hazardous waste. To some extent, workers are exposed to harmful chemicals through breathing, eating, and touching. Sometimes, acute poisoning cases are reported in places where no safety measures are in place. On the other hand, chronic low-level exposure might result in the accumulation of toxins. There are research associating chemical exposure with damage to organs and the development of diseases in the whole body. The literature mentions the slow recognition of poisoning signs. Lack of knowledge is a factor that makes the situation worse. Emergency response systems aren't usually up to the

task. Chemical poisoning keeps on being very dangerous. Preventive measures are the only way to ensure that exposure is minimized.

Various studies have reported that prolonged contact with dangerous substances leads to the development of chronic diseases, among other things. Research findings show that the workers who deal with hazardous waste are likely to develop cancer. Also, there are some cases of neurological disorders related to exposure to chemicals. In people under the long-term effects of chemical exposures, cognitive decline and damage to the central nervous system have been noted. Reproductive health is another area where long-term exposure has an adverse effect. As a matter of fact, researchers point out that it can take many years for the symptoms of occupational diseases to show up. This makes it difficult to diagnose and grant compensation. Workers suffering from chronic diseases will face major impacts on their lives. Hence, long-term monitoring is of utmost importance.

The literature is acknowledging more and more the psychological stress of hazardous waste workers. Reports of high anxiety and depression levels among the workers can be found in some studies. Mental stress is mainly caused by job insecurity and hazardous working conditions. Waste work stigma impacts the workers' self-esteem negatively. One of the most mentioned sources of occupational risk awareness is emotional burden. The stress levels are worsened by the long working hours and the little time for rest. Psychological distress is a factor that diminishes job satisfaction. It also affects productivity and safety negatively. Mental health has been a commonly neglected aspect of occupational health programs. It is quite imperative to consider the psychological well-being of workers.

Workplace safety training is generally accepted as a significant preventive measure. Research indicates that workers who have undergone training possess better skill in the safer handling of hazardous substances. Training has a positive effect on the knowledge of risks and safety measures. Constant refresher programs lead to better adherence to the rules. The literature points to the necessity of training in emergency response situations. Health monitoring

programs make it possible to discover occupational diseases in their early stages. Keeping track of exposure levels helps in taking preventive measures. The literature underlines the need for safety management systems that are integrated. The active involvement of the organization determines the training effectiveness. A safety culture is a prerequisite for lasting protection.

Although there is compelling evidence of the hazards to health in certain occupations, the literature shows that the safety of the workers is frequently put on the back burner in favor of operational efficiency. The pressure to produce more quickly leads to taking safety measures. Health considerations are often the last thing on the minds of the managers. Inadequate safety infrastructure is reported by the studies as a result of lack of investment. There is no consistency in regulatory enforcement of occupational health standards. Informal waste sectors are the least cared for. Literature emphasizes the need for integrated approaches that can coexist and be mutually beneficial, i.e., safety and efficiency. The health of the workers should be the primary concern of the waste management systems. Human well-being should be the priority in the sustainability practices. All these findings set the stage for the urgent call for change in policy and L Fazzo et. Al., 2017

One of the major outcomes of the systematic review was the conclusion that living near hazardous waste sites had indirect effects on health which were measurable and statistically significant. The systematic review was carried out in the context of the European Environment and Health Process. The research effort was the systematic review of the published epidemiological evidence between 1999 and 2015 based on a predefined PECO approach which specifically looked at the populations living near hazardous waste sites and their associated health outcomes. A total of 57 epidemiological studies were selected from the Medline and EMBASE databases after a rigorous quality assessment that considered study design, exposure assessment, outcome measurement, and control of confounding factors. The review found that residential exposure to hazardous waste was linked to 95 different health outcomes, which included cancers, respiratory disorders, congenital anomalies, and infertility. There

was enough statistical evidence to infer a relationship between the exposure to oil industry waste with high hydrogen sulphide emissions and the occurrence of acute health symptoms. The studies showed that the relationship between exposure and the following conditions was weak: liver, bladder, breast and testicular cancers, non- Hodgkin lymphoma, asthma, congenital anomalies, neural tube defects, urogenital and musculoskeletal anomalies, low birth weight, and preterm birth. For the rest of the health outcomes, the evidence was classified as inadequate because of inconsistency or the quality of the studies being limited. Though many conditions did not have conclusive causal proof, the consistency of findings across different studies was seen as a significant public health issue. The review brought to light the health effects that in the past were not duly recognized and were caused by the exposure to hazardous waste among residential populations. In short, the research unambiguously asserted that hazardous waste exposure was a significant public health concern and firmly called for the imposition of stricter policies in the area of hazardous waste management, enhancement of regulatory enforcement, and the total eradication of illegal as well as outdated waste disposal activities at international, national, and local levels as a matter of urgency.

III. PROBLEM IDENTIFICATION & OBJECTIVES

Problem Identification- In the research, the descriptive research design was the method used to explore systematically hazardous waste management in a variety of settings, including hospitals, industrial sites, and municipal waste management centers. This methodology allowed the researchers to take a detailed picture of the current practices since they could record the whole process of waste segregation, storage, transportation, and so on. The study, using descriptive characteristics, then recognized the strengths and weaknesses in operational methods, regulatory compliance, and safety protocols. The researchers went through important parameters like worker awareness, use of personal protective equipment, and training programs to comprehend their role on health and safety in both the occupational and environmental areas. Descriptive

aspects offered a very clear picture of the world as it was managed in case of hazardous waste, pinpointing the sources of concern for policy and intervention. It also allowed the study to gather both numerical and categorical data, which could later be analyzed for trends and associations. In addition, the descriptive design helped in creating a baseline understanding which was necessary in evaluating the effectiveness of current practices. It threw light on the common operational difficulties like infrastructure inadequacies, insufficient monitoring and procedural ineffectiveness. The design was very helpful in comparing different facilities with regard to their practices; also it helped in revealing the areas of compliance and non-compliance. Ultimately, the descriptive framework was the bedrock of a rigorous and methodical inquiry.

Moreover, the study employed an analytical research design to study the effects of specific practices related to hazardous waste management on environmental and occupational health outcomes. The use of analytical methods permitted the researchers to scrutinize the relationships of causes and correlations between independent variables like waste separation techniques, storing methods, treatment processes, and compliance with regulations, and the dependent variables which are the quality of air, water, and soil, as well as the health of workers. The study, besides collecting observational data, also employed statistical analysis and thus it was able to estimate the extent to which effective or poor waste management resulted in environmental pollution and occupational hazards. The analytical approach also took into account the role of Objectives-

The research utilized a combination of qualitative and quantitative methods in order to deliver a complete analysis of the hazardous waste management practices and their effects. Through interviews with facility supervisors, safety officers, and workers, qualitative data were obtained in order to gain insights into the procedural details, challenges faced, and perceptions held with respect to occupational safety and environmental protection. Field observations, and structured checklists taken at the same time also helped to show off the adequacy of infrastructure, compliance with safety standards, and

to document the practices being used at that time. Quantitative data were derived from structured questionnaires that captured numerical data on worker exposure, the incidence of unsafe practices, and the results of environmental monitoring. The application of the mixed-method approach not only made it possible to cross-check data from different sources but also increased the trustworthiness and legitimacy of the findings. By bringing qualitative insights together with statistical analyses, the study was capable of not just quantifying the risk levels but also explaining the reasons behind non-compliance or inefficiency in waste management practices. This all-inclusive method ensured that the conclusions drawn were based equally on empirical evidence and practical context. Moreover, it made possible the detection of patterns and trends across diverse facilities, giving rise to insights that could be acted upon concerning policy, training, and operational improvements. In short, the mixed research design granted the study the opportunity to thoroughly cover its aims linking the practices of hazardous waste management to the measurable impacts on the environment and the health of workers in the occupation.

Comparative Analysis: Comparing safety compliance across different work zones (scaffolding, electrical, excavation).

Trend Analysis: Identifying recurring hazards and lapses over the 20-day period.

The analysis revealed that while awareness of safety protocols exists, implementation is inconsistent. PPE compliance is below acceptable standards, especially for harnesses at height. Electrical hazards and poor fire safety preparedness pose significant risks. Worker interviews highlighted lack of formal training and weak communication of emergency procedures

IV. DATA ANALYSIS

The data analysis was performed on the responses of 230 participants who were working in hazardous waste management at hospitals, health care facilities, and municipal and industrial waste management sites. It was found that the practices of hazardous waste management differed a lot between the different

types of locations and the operational roles. According to descriptive statistics, most locations had basic waste handling practices, but the degree of consistency and compliance varied from one place to another depending on the provision of infrastructure, training, and supervision. The results indicated that in some places, hazardous waste management was still largely through procedures rather than being systematic since gaps were found in segregation, storage, and disposal practices. The use of tables, graphs, and charts made it easier to compare practices in various areas and to determine the areas where compliance and non-compliance occurred.

The population study has shown that the male workers made up the majority of the hazardous waste management staff, as 60% of the surveyed persons were males, which is a direct result of the physical and operational nature of the tasks involved in waste handling. When it comes to the age groups of the respondents, the major share, representing 38.3%, was to the 31–40 years group, which is a clear sign that the hazardous waste management operations were mainly led by the ones in their prime working years. This age group is usually equipped with a mix of physical strength and professional maturity, which are the two main requirements for the safe handling of hazardous materials. Moreover, a good percentage of the respondents were also in the 41–50 years age group, which means that there are some senior and very knowledgeable staff in the company.

According to the work experience, the research uncovered that the majority of the participants (35.7%) had been working in hazardous waste management for 5–10 years. This degree of experience was interpreted as a moderate level of acquaintance with waste handling procedures, safety measures, and law compliance. Workers falling into this experience bracket were most likely to have developed their practical skills by being regularly engaged in waste management operations. On the other hand, the presence of respondents whose work experience was less than five years also pointed to the fact that there is a need for further training and supervision to ensure that safe practices are followed. The varied experience levels accentuated the necessity of structured training programs for the

uniformity of hazardous waste management practices throughout the different facilities.

The allocation of participants in the waste management hierarchy, such as waste collection, storage and transportation, treatment and disposal, and administration or safety, provided the study with the opportunity to include a broad range of perspectives as well as the difficulties that different stages of the waste management process might bring. The participation of both the front-line staff and supervisors together made the findings more trustworthy because it covered both practical implementation and policy-level decision-making. In general, the demographic characteristics showed that the sample of the study was well-balanced and reflected the hazardous waste management industry very well, thus reinforcing the validity of the analysis and interpretations made later. Descriptive statistics were used to summarize responses on waste management practices. Table 4.2 highlights the frequency of compliance with key practices.

V. RESULTS & DISCUSSION

The results of the study were interpreted to mean that hazardous waste management practices directly and measurably impacted the quality of the environment and the health of the workers. The study showed that even though basic waste handling practices were there in healthcare, industrial, and municipal facilities, they were not always followed. The places that had proper waste segregation, safe storage, and correct disposal methods had better conditions for the environment and less occupational health problems reported. On the other hand, places with poor compliance had more cases of environmental pollution and worker exposure. These trends imply that the effectiveness of the operations, rather than just the presence of the guidelines, was the factor that decided the outcomes.

Additionally, it was found that the safety measures in the workplace had a great influence on workers' health. The workers that always had the protective gear on and had gone through the official training were the ones reporting the least cases of respiratory ailments, skin diseases, and injuries. This pointed out that training and safety awareness helped the

interaction between waste management practices and health effects. The interpretation was in line with earlier studies which pointed out that not enough training and PPE using increased occupational risk for hazardous waste handlers. But on the other hand, the current study took the knowledge further by proving this association across different types of facilities rather than just one sector.

The appraisal of the environmental outcome indicated that the wrong methods in handling waste had a direct link to the decline in the quality of the air, water, and soil around the selected plants. The places where the disposal practices were not up to the mark and the regulations were not followed showed higher contamination levels than the ones that complied with the regulations. This understanding was in line with previous research, which had already connected the poor disposal of hazardous waste with the long-term degradation of the environment. Nevertheless, the results brought out the fact that better monitoring and enforcement could, to a significant extent, reduce the impact of pollution on the environment and thus it could be concluded that pollution was not an inevitable occurrence but rather a situation that could be prevented.

The demographic analysis brought out that majorly male workforce was performing the hazardous waste management-related activities with the majority of the respondents being in the 31-40 years age group and having moderate experience in the job. This scenario indicated that hazardous waste handling was mainly assigned to workers who were physically fit to take up and manage difficult and risky tasks. The high number of middle-aged workers pointed to the fact that the management relied on people who were strong physically and had a few years of occupational experience. The demographic features showed that the workforce was not new but made up of individuals who had been in the waste management sector for quite some time. This interpretation supported the view that hazardous waste handling was regarded as a labor-intensive job which required constant physical presence of workers.

VI. CONCLUSION & FUTURE SCOPE

Future studies may adopt a longitudinal research

design to examine the long-term environmental and occupational health impacts of hazardous waste exposure over extended periods.

Further research could expand the geographical coverage to include multiple regions or states, enabling comparative analysis across different regulatory and infrastructural contexts.

Inclusion of the informal waste management sector in future studies would provide a more comprehensive understanding of exposure risks and safety challenges faced by unregulated workers.

Advanced environmental sampling and laboratory-based analysis of air, water, and soil could be conducted to obtain more precise and objective contamination data.

Future research may explore the effectiveness of specific waste treatment technologies and disposal methods in reducing environmental pollution and occupational hazards.

Studies could investigate the role of psychosocial factors, such as job stress, work satisfaction, and mental health, in influencing occupational health outcomes among waste handlers.

Comparative studies between public and private waste management facilities could provide insights into differences in compliance, resource allocation, and safety practices.

Future research may assess the impact of targeted training and intervention programs on improving waste management practices and reducing health risks.

Incorporation of advanced statistical modeling and risk assessment tools could strengthen causal inference and predictive analysis of hazardous waste impacts.

Interdisciplinary research integrating policy analysis, environmental science, and occupational health could support the development of more effective and sustainable hazardous waste management frameworks.

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