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Management of Hazardous Waste at Construction Site

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Abstract: *Waste management is an important part of the urban infrastructure as it ensures the protection of the environment and of human health. It is not only a technical environmental issue, but also a highly political one. Waste management is closely related to a number of issues such as urban lifestyles, resource consumption patterns, jobs and income levels, and other socio-economic and cultural factors. One characteristic feature of sustainable waste management is that it is achieved by using the technical, organizational, and financial resources available in a particular locality. The waste management situation in the countries around the world is by no means uniform. It is easy to forget that the category of countries that are now 'fine-tuning' their waste management systems is a minority. Construction and demolition waste management is becoming increasingly important on construction sites as landfill space in India is rapidly depleting and waste management costs are rising. Due to these factors waste management plans are seen as a good response to minimizing waste on site and this thesis aims to investigate how to implement such a plan on a practical case study as well as investigating the legislation regarding construction and demolition waste along with market availability for the reuse of the waste. Main contractor surveys were also carried out in order to gain a better understanding of current attitudes within the industry and these surveys are analyzed. A survey was also carried out among sub-contractors but this survey has not been used for this thesis as the study is on-going. This research concentrates on the possible waste management strategies which a company can use to successfully implement good practice waste management. The initial research found that the construction and demolition waste topic is a worldwide issue with research being compiled constantly in order to help contractors implement successful waste management strategies. The initial stage of research involved a review of the legislation, theories and studies related to construction and demolition waste management. This research revealed that while good practice waste management is challenging, it is an achievable goal. Typically, the implementation of waste minimization techniques requires three basic components; waste minimization during the design stage, source reduction and recycling. Waste minimization during the design stage has huge potential to impact positively on waste minimization as it is during this stage that some of the major decisions are made such as the form of the building. Source reduction helps avoid waste generation while recycling helps to conserve natural resources and prevents wasted materials from entering the waste stream. There is huge potential for the minimization of construction waste which arises through both design and the construction process. In order to reduce wastage rates, it is important to focus on both issues. The most important factor for on-site waste management is the on-site segregation of the waste. If this process fails then it becomes difficult for the waste to be recycled. At the outset this will take some extra time and training of the construction staff but once the segregation habits are established the waste segregation on site can be done at a small or no additional cost.*

Keywords: Waste.

I. INTRODUCTION

Rapid industrialization, urbanization and rise in living standards of people is most commonly associated with the problem of environmental pollution. For developing countries, industrialization is a necessity and demands to build self-contained uplifting of nation's economy. However, industrialization on the other hand has also caused serious problems relating to environmental pollution. Therefore, wastes seem to be a by-product of growth. With increasing demand for raw materials for industrial production, the non-renewable resources are diminishing day-by-day. Therefore, efforts are to be made for

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controlling pollution by conversion of these unwanted wastes into functional raw materials for constructive use. Disposal of industrial solid waste is concomitant to lack of infrastructural facilities and negligence of industries to take proper safeguards. Studies show that the large and medium industries located in recognized industrial areas still have some arrangements to dispose solid waste.

The problem continues with small scale industries. There are no regulatory measures in these industries find it easy to dispose waste illegally which makes it difficult for local bodies to collect such waste. In some cities, industrial, residential and commercial areas are mixed and thus all waste gets intermingled. Therefore, it becomes necessary that the local bodies along with State Pollution Control Board (SPCB) work out requisite strategy for organizing proper collection and disposal of industrial solid waste. Management of Industrial Solid Waste (ISW) is not the responsibility of local bodies. Industries generating solid waste have to manage such waste by themselves and are required to seek authorizations from respective State Pollution Control Boards (SPCBs) under relevant rules. However, through joint efforts of SPCBs, local bodies and the industries, a mechanism could be evolved for better management.

Why regulations are needed to manage industrial waste?

- Protecting human health and the environment
- Tailoring management practices to risks
- Affirming state and community leadership

1.1 Status of the Problem: Local, National & International

A. Local and National Problems

Predominant initiators of industrial solid wastes are the thermal power plants producing coal ash, the integrated Iron and Steel mills producing blast furnace slag and steel melting slag, non-ferrous industries like aluminum, zinc and copper producing red mud and tailings, sugar industries generating press mud, pulp and paper industries producing lime and fertilizer and allied industries producing gypsum.

B. International Problems

Industrial pollution and waste pose potential threats to human and ecological health if not properly managed. The concerns range from toxic effects on fetuses and children to the health implications of low-level exposures to multiple pollutants and the degradation of habitats and ecosystems. These concerns do not stop at the borders, because some pollutants can travel long distances and waste is shipped to recycling and disposal sites across political boundaries.

C. Problem related Health, Safety and Environment

The pollution and waste tracked through Pollutant Release and Transfer Registers (PRTRs) and regulated by environmental laws in North America are those the national governments have identified as raising concerns about human health or the environment. The effects of certain toxic chemicals on the health and development of children and other vulnerable groups are of a special concern. Researchers describe “windows of vulnerability” during fetal and child development in which toxic exposures can have particularly devastating effects. Although the traditional focus has been on overt health effects such as cancer, scientists are increasingly worried about the more subtle effects of low-level toxic exposures, such as impairments in endocrine and neurological functions. Municipal waste incineration, medical waste incineration, burning of hazardous wastes in cement kilns and backyard waste burning were among the top sources of dioxins, according to US and Canadian inventories. Dioxins, like some other PBTs, can be dispersed long distances by air currents and other environmental pathways and tend to settle in colder regions. Therefore, decisions on how to manage wastes have environmental implications.

II. LITERATURE REVIEW

According to the Study on Resource Efficient Use of Mixed Wastes (Deloitte 2017, 7) for the European Commission, CDW creates over 800 million tons per year and its stream of waste is one of the heaviest and most voluminous. CDW accounts for roughly 25-30% of all waste produced in the EU.

Main constituents of CDW are:

- Concrete

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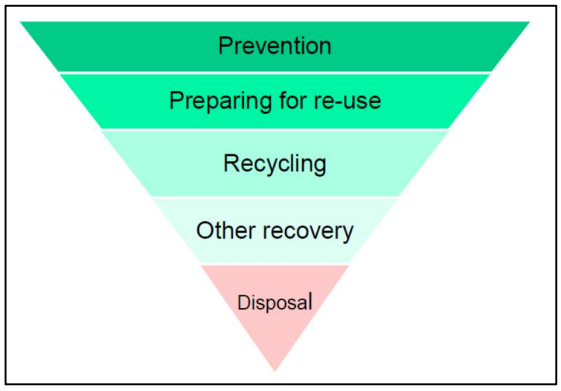
- Bricks
- Gypsum
- Wood
- Glass
- Metals
- Plastic
- Solvents
- Asbestos
- Excavated soil.

Most of CDW material is highly recyclable and reusable, some components of CDW have high resource value, and there is an established market for re-use materials collected from demolition of roads, drainages and other, i.e. bitumen and aggregate from asphalt roads, bitumen roofing tiles.

Recycling of CDW in the EU is yet to reach its full potential, with the performances of recovery of material varying for the Member States of EU greatly, from 10% to more than 95%. Member States with highest performances provide proven practices for the low performers to achieve better results (Deloitte 2017, 7). It is also important to state, that official CDW data is often not a completely reliable source of information (Deloitte 2017, 40), however it can still provide context for comparisons.

The Russian Federation experiences a rapid increase of new construction. According to the Federal State Statistics Service construction has grew by a factor of 3.4 by cost volume in the span of 5 years from the year 2000 to 2005, and has amounted to 1711.7 billion rubles. While there is also a clear annual increase in built apartments. (Oleynik 2016, 2.) Officially CW drew a total volume of 62.57 million tons in 2019 in the Russian Federation, which places it at 0.83% of all industrial waste generated in the country, Environment contamination and potential profit loss are not the only problems that we face. It is considered, that construction and demolition waste only occasionally contain any harmful materials, thus it falls into categories 4-5 by the Order of the Ministry of Natural Resources of Russia N 536 (2014), the categorization being established in terms of hazardousness in the Federal Law no 89 (1998, section 4.1). CW is considered fit for landfilling, often without any liner material, making it cheap to deal with construction waste and harder to control illegal waste dumping, marking that as a primary example of miscellaneous issues, brought about by undeveloped waste handling practices.

The European Parliament and the European Council provide the EU with wide guidelines and frameworks on regulating waste management in the Member States of the EU. These guidelines with the help of thorough studies of the waste situation in the EU, such as the Development and implementation of initiatives fostering investment and innovation in construction and demolition waste recycling infrastructure (IDEA Consult 2018) study, and the Resource Efficient Use of Mixed Waste (Deloitte 2017) are aimed at aiding the development of Member State waste management situation. Frameworks and guidelines are provided via the Circular Economy Package, consisting of the regulation for the organic production and, more to the issue of CW, four directive amends published in the Official Journal of the European Union (EU Directive 2018/851) and other documents, like the Construction and Demolition Waste Management Protocol (Ecorys 2016) and the EU Guidelines for audits before demolition of buildings (2018).



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In general, the EU directives are aimed at conserving and improving the quality of the environment and promoting rational use of resources. The key goal of the Package is to further adopt the "waste hierarchy" (Directive 2008/98/EC), that puts in a priority order types of waste management practices, going from waste prevention as a top priority measure to waste disposal as the last possible solution.

In the Figure 1, you can see how the waste management practices go from most desirable and optimal for a sustainable environment and economy to least desirable, meaning stakeholders must go from each upper step to the lower only in case if the higher priority measure is impossible to carry out. The Waste Framework Directive offers a framework for improving resource efficiency in the European recycling society, mandating Member States to reach a minimum of 70% by weight of non-hazardous CDW to be re-used, recycled or be otherwise recovered. While most of the European Member States are already exceeding the 70% mark by 2016 (European Environment Agency 2020), they set the standard for other countries, which are still working towards reaching the set goal.

III. OVERVIEW OF CONSTRUCTION WASTE MANAGEMENT

Construction Waste Management Impact on Environment and Economy

Construction waste management has its influence on the environment in all stages of the construction process. Waste is generated during acquiring raw materials, during the production of construction materials, at the construction site and during the exploitation stage, up to the deconstruction or demolition of the building or structure. As well as residue mineral materials, that accumulate through most of the stages of construction, other waste is also being generated during the technological processes of manufacturing and the exploitation\service stages. More than 90% of open-pit mines in the India purposed for the subsequent production of construction materials. Mineral raw material is often acquired through the open-pit method, which causes number of negative effects on the environment and the economy. Such effects are destruction of soil, disturbance of water regimes, air, water and soil pollution, birds and animals leave their habitats, vast areas of land are being rendered unusable for farmer activities. These repercussions translate into significant loss of habitable and useful land, cause great disturbances for the local flora and fauna, relocate range animals and ruin the natural balance in the area. Another influence, that CWM has on the environment, comes from the practices used to manage hazardous or toxic materials, where improper handling may result in damaging soils or waters, creating health risks for the population and future negative effects on nature, with possible excessive depletion of natural resources

Economically, apart from unnecessary loss of valuable natural resources, poor handling of construction waste creates a number of unfavorable circumstances. Excessive amounts of waste being dumped in landfills results in a premature filling of landfills, driving further expenses on new landfill preparations and on fixing the negative effects on the environment. Lost opportunities of industrial symbiosis, where strategies like input replacement could significantly lower finances spent towards input materials by lowering the share of virgin materials with the inclusion of wastes in their place. Embedded energy, hidden in the waste materials, being wasted by not saving it via replacing virgin materials with recycled materials. Proper construction waste management is essential for maximizing material use and increasing resource efficiency, while minimizing costs and producing sustainability. This is achieved by relying more on recycled and re-used materials, lowering the demand for virgin materials.

Waste Management at Construction Site Level

Construction site administration governs all activity on site, including the maintaining of cleanliness and waste handling. That way waste management on construction site level is one of the key important areas, when discussing CWM effectiveness.

CWM on construction site has the power to decrease the amount of money spent on raw construction materials, increase work efficiency, supply fit for reuse or recycling material and other.

According to the International Report on Construction site management and minimization (Macozoma 2002, 25), the benefits of CWM on site are as follows:

- Avoidable waste generation reduction on site;
- Prevention of waste of entrance the national waste stream and waste redirection;
- Minimization of waste transportation costs;
- More efficient material procurement due to higher efficiency of material use and use of secondary materials;

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- Optimizations for the protection of contractor's margin;
- Site efficiency and performance growth.
- These benefits are due to a number of methods of waste management on site, being implemented by stakeholders
- Waste specifications;
- Waste management contract language;
- Strategies of waste avoidance;
- Waste management planning;
- Procurement and use of recycled and secondary materials and products;
- Site efficiency and performance growth.

Waste Management at Design Level

As put at the first step in the waste hierarchy, shown in the Figure 1 above, waste prevention is the most logical and least resource consuming waste management strategy. Construction projects are significant in their scale, long lasting and investment intensive. With its complicated nature, construction industry has many stakeholders, and approaching construction waste management is a difficult topic. Nevertheless, preventing excess waste from ever occurring significantly simplifies other waste managing practices directly, due to fewer waste to deal with. Reduction of waste can achieve by means of choosing the right material with high application efficiency, negating waste generation through compilation of excess material. The material packaging, worker skill required for the installation without extra material loss or other technological features of any given material have the potential to make the design noticeably more sustainable, removing unnecessary trouble. Furthermore, designs, that keep the end of the building's lifecycle on the agenda, succeed in the waste management by far, by means of choosing such a material that can be easily deconstructed and used elsewhere. Proper material choice and choice based on versatility have also the ability to compensate for over/understocking of materials, with other projects in mind, so that materials from one project can go to another. Designing and planning a new construction, renovation or other project in the building sector is a dynamic process involving the practice of creating multiple designs, close contact with stakeholders. It is near to impossible to plan every detail perfectly from the start, so series of trial and error continue through the design and planning stages, almost always making their way into the stage, at which the construction has already begun and lasting up until the end. This means that mistakes leading to reworks are bound to happen at some scale, resulting in increased costs and additional waste.

IV. CASE STUDY

In order to conduct this research, the qualitative approach was chosen as an efficient method of obtaining good understanding of phenomena, with possibility of in-depth learning about certain causes and behaviors. As this study foremost is learning the used practices and ideas, qualitative approach should provide a better starting point for the further developments. The idea of approaching the problematics with a qualitative approach is due to the need to achieve detailed understanding of various sides and perspectives on the construction site. This is important for later development, as with the large amount of stakeholders it is crucial to get ideas directly from the ongoing construction phases and day-to-day interactions. Because the research questions try to open the topic from multiple approaches, the real-life context in the form of case study suits well to help to create development suggestions for the future.

The case study's field research was carried out at Capacite infra Ltd projects site. The case study was selected as the methodology to carry out the research. In this case the content had a qualitative approach, as stated above.

Case studies consisted of visits to each construction site, a tour around the points of interest on site, accompanied with a thematic interview about internal operations and behavioral overlooks, as well as inspection of relevant documentation, and a quantitative overview of waste output situation around cities (Figure 2). The documentation of the study was supported by photos from the sites.

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Project Site Descriptions

Capacite infra Ltd is realizing a number of complex residential areas in a number of cities in the India Federation and in Gujarat and Maharashtra in particular. The projects include construction of residential housing in the form of blocks of flats, internal infrastructure, and in some projects also municipal buildings like schools and government offices. The construction sites are situated in the city of Ahmedabad Gujarat.

The residential complex includes five 20-story buildings and an adjoined parking building. The residential buildings share common material and technology choice. A combination of cast-on-situ and precast techniques is used in this project; thus, a single building consists of both. The structural material choice for the houses is carried out as follows: concrete pile foundation, concrete slab foundation grillage, cast-on-situ concrete walls, precast concrete wall panels, brick external non-load bearing walls, expanded clay roof insulation, rolled bitumen roofing, mineral wool plates for external insulation. The energy efficiency class of the buildings is "A", very high.

Case Study Analysis and Findings

The conducted construction site visits presented nearly all stages of construction. The tours were carried out trying to obtain as much background as possible in terms of the construction technologies used, material choice for different structural elements and other applications, work ethics and behaviors, work equipment, and other details, somehow connected to the topic of CWM.

The following findings are discovered through investigation of all stages of construction, seen fit for the research at hand, from groundworks and setting a foundation to the finalizing decorative works in apartments inside residential buildings. Because all main stages of the construction process were examined, we are given a wider view on how the stages work with each other regarding waste generation, potential secondary uses of waste, waste collection and other. The construction site tours were started from the administrative building on the site, first evaluating the cleanliness and organizational culture in the matter of littering and relation towards waste.

Then, the tour advanced towards the earliest stage of construction, which at the site of "Mango Haven" residential area happened to be foundation works during the visit special attention was given to waste collection at each viewed construction process. With the help of the technical supervision it was determined who and where was responsible for the cleaning works and waste collection. Waste collection points and containers were examined in terms of location and waste sorting capabilities.

Administrative Facilities

Starting from the administrative site headquarters a clean environment has been observed, though no sorting means are provided in terms of sorting containers, solid waste is always placed inside the collection points, showing a good level of organizational culture. In this fashion the work environment stays clean, showing an example for contractors and setting a reference for the workplaces on site.

Groundworks

Even though the ground preparation stage was not observed during the visits, ground piles and other natural material storages were discussed on site. During the ground preparation and excavation, the main waste being generated is solid dirt. From removing the soil layer, the fertile soil is reserved for later use in creating green areas around the streets and yards. The amount of saved fertile soil depends on its quality and the initial taken amount of soil usually exceeds later needs, thus excess soil is driven away from the construction site and disposed of. An interesting and unique practice was seen at the "Mango Haven" site, where from the initial cleaning of the territory were saved and stored on the site natural boulders as a decoration on the finished residential streets. This practice is a good example of ingenious and effective use of otherwise useless and thrown away materials. Although it is unclear whether the decision has been made on the design stage or on the construction site itself, it is a valuable precedent for using existing natural features of the land for the benefit of the future construction. Excavated ground from the digging of pits is also stored on the site, unless the ground composure is clay, which is not suitable for backfilling. Saving and later using any amount of excavated soil and ground is crucial to reducing generated waste amount and it saves money for waste disposal.

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Foundation works include the use of materials such as concrete, geotextile, waterproofing material and hard insulation. On the "Mango Haven" construction site the process of casting a concrete foundation slab was observed. Although it is a common practice to bury small amounts of excess material as a backfilling, that was not observed on the site. Another important thing noticed at that stage is the safety barriers set around the excavated pit. It is noteworthy that on all the examined construction sites safety measures are being responsibly addressed, and the use of wooden barriers is a common occurrence on every stage of the construction. The safety barriers are constructed of wooden planks and as easily transported around the site as disassembled and assembled anew. Thus, the safety barriers' lifespan is only limited by the wooden planks lifespan, virtually lasting up until the end of construction. Not all barriers are reused and some are thrown away, which leaves room for improvement.

On-Site Handling, Storage and Processing of Solid and Hazardous Waste

Below table for details hazardous waste at site

Sr no	Item	Qty	Weight (KG)	Pics
			"E" Waste	
1	Power Supply card	10	200	
2	Ups	2		
3	Battery	30		
4	Servo motor	2		
5	Contactor	29	15	
6	MCB	5	15	
7	Phase Controller	4		
8	PLC	1		
9	PLC Card	2		
10	VFD	2		
11	PCB Card	7		
12	Helogen Fixture	2	4	

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13	Chawk	1		
14	Capacitor	1		
15	Sensor	1		
Plastic Waste				
16	Garbage		5 000	
17	Plastic assembly waste		5 000	
18	Other plastic waste		2 000	
Chemical Waste				
19	Lacquer Sludge	---	2 000	
20	Empty chemical drums	---	3 000	
21	Used Oil	---	2 000	
Construction Waste				
22	Wooden Waste	--	2000	
23	Metal Waste	--	50000	

Process/The different components of HWMS in site given below

1. On-Site Handling
2. On-site Storage
3. Collection
4. Segregation
5. Handling and Transportation

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6. Emergency Planning
7. Treatment & Disposal

Collection, segregation, handling, storage, transportation and treatment & disposal of hazardous wastes has been drawn up in order to minimize hazards to human health or the environment from fires, explosion or any unplanned sudden or non-sudden release of hazardous waste constituents to air, soil or water. However, the same is quite unlikely considering the constituent of hazardous waste.

A. On-Site Handling

On-site handling methods and principles involve public attitude and individual belief, and ultimately affects the public health. It is an activity associated with the handling of solid waste until it is placed in the containers used for its storage before collection. This may take place at any time before, during or after storage. Importance of on-site handling of solid waste:

- Reduce volume of waste generated
- Alter physical form
- Recover usable materials
- On- site handling methods:
- Sorting
- Shredding
- Grinding
- Composting

B. On- Site Storage

The first phase to manage solid waste is at industrial level. It requires temporary storage of refuse on the premises. The individual person has responsibility for onsite storage of solid waste. For individual location on-site storage of solid waste is the beginning of disposal, because unkept or simple dumps are sources of nuisance, flies, smells and other hazards. There are four factors that should be considered in the onsite storage of solid waste. These are the type of container to be used, the location where the containers are to be kept, public health, and the collection method and time.

C. Collection of Hazardous Waste

This is the removal of refuse from collection points to final disposal site. It is the most expensive as compared with other operation and management procedures, because it demands special vehicles, experienced people to manage, more manpower, hand tools, and more funds for fuel, salary, maintenance, gathering or picking up of solid waste from the various sources, taking the collected wastes to the location where it is emptied, and unloading of the collection vehicle. Collection cost has been estimated to represent about 50% of the total cost of collection when a sanitary landfill is used as means of disposal, and 60% when incineration is used. Home collection of solid waste generally is done by a private collector or a local government-owned and financed operation.

Collection Process

- Phase 1 - Waste to dustbin
- Phase 2 - Dustbin to truck
- Phase 3 - Truck from location to location
- Phase 4 - Truck to transfer station
- Phase 5 - Truck to disposal

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D. Segregation

M/s. CIL is providing awareness training programme to workman crew for segregation of wastes and shall promote recycling and reuse of segregated materials. The company should undertake phased programme to ensure industrial participation in waste segregation.

G. Transportation

For the transportation of industrial hazardous wastes, tractor trolleys/trucks with hydraulic unloading mechanism are proposed to be used. As far as possible, hazardous waste should be taken in sacks and containers and loaded waste should be fully covered with HDPE sheet in order to avoid littering of the waste on the road. The trolleys/trucks to be used for the transportation of the hazardous waste should not be used for any other purposes. To avoid usage of these trolleys/trucks for any other purpose, the management should preferably own these trolleys/trucks and earmark them for the above purpose and then paint them with a distinguishing color (say Black) and display on these trolleys/trucks - in bold red letters "HAZARDOUS WASTE" (on a fluorescent yellow background). The inner surface of each trolley/truck should be coated with epoxy resin and in order to avoid spillage during transportation a free board of about 15 cm should be maintained between the surface of the waste and the top edge of the trolley's/truck's sidewalls.

H. Storage at Yard

Scarp Storage facility with impermeable flooring is available for encountering problems on account of equipment failures, etc. the waste generated should be stored in intermediate hazardous waste storage facility at secured landfill disposal site.

Details of storage yards

SL/No	Scarp Yard Name	Capacity
1	Garbage Scrap Yard	5 Ton
2	Assemble Scrap	2.3 Ton
3	BMC Scarp Yard	5 Ton
4	Plastic Waste Yard	5 Ton
5	Metal Scrap Yard	70 Ton
6	Chemical Drum Yard	2.3 Ton
7	Used Oil Yard	1 Ton

Scrap Handling Operation

- Before starting operation, Wear the Safety shoe, Cap.
- Create Scrap Note in the Portal.
- Keep scrap in trolley.
- Get signature of authorized person on scrap note.
- Move Trolley to scrap yard.
- Verify Scrap Quantity with scrap note, security guard must be available at the time of counting & weighing.
- Make entry in manual register with quantity and weight.
- Unload scrap to respective scrap location.
- Monitor scrap yard maximum limit.

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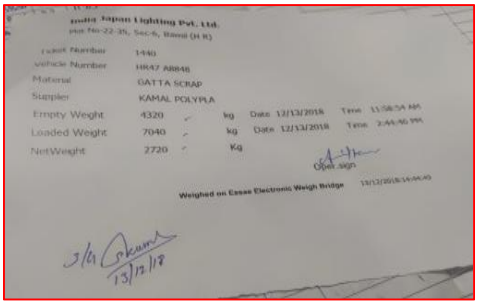
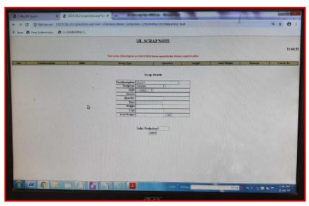
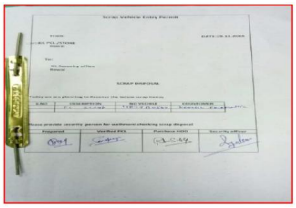
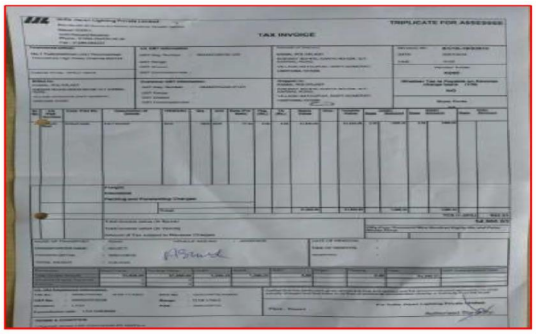
- Call scrap dealer for vehicle for next day.
- Arrange scrap vehicle entry permission at gate with required format.
- Park empty vehicle at Weighing machine for weighing.
- Take weighing slip of empty vehicle.
- Start loading of scrap in whose vehicle weighed.
- Do again weighing of loaded vehicle.
- Take weighing slip of vehicle.



- Make entry in manual Scrap sale register with quantity and weight.
- Show the scrap sale register and weighing slip to finance team & take signature.
- Finance team will check account of Scrap dealer that how much amount available for scrap and security money.
- I.T. will be create sales order for scrap invoice.

- Give request to the Dispatch team for invoice.



- Make Hazardous Waste Manifest along with tremcard copy

I. Disposal and Treatment

After all above-mentioned activities final disposal of hazardous waste will be carried by external vendor Saurashtra Enviro Project PVT.LTD and Detox India PVT.LTD through hygienic and safe manner for prevention and mitigation of the adverse environmental impacts likely to arise from the secured landfill facility. Hazardous waste may be disposed of to the secured landfill at all time but precaution must be taken especially during rainy season when excessive leachate is generated. To check this problem, cover the sub- cells of the facility with Large poly bag and ensure that no water comes in contact with the waste. Use of spray water with dust suppressing chemicals and covering of waste layer with fresh soil & compaction is maintained in order to restrict blowing away of the waste dust with the wind. Provide collection and conveyance system for leachate and it has to be treated before discharge. Gas collection system has to be installed for

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gas generation from the closed sub-cell/facility. Wastewater has to be treated prior to discharge. Environmental sampling with respect to ambient air quality, ground water quality, surface water quality, and soil quality around the site shall be periodically monitored for analysis. In case of pollution is noticed, adequate measure must be taken. Refer Annexure- and – Membership certificate.

Risk Mitigation Measures

Company is take care of employees' health, management has adopted a practice of preventive and predictive maintenance looking to the nature of hazardous waste and chemical being handled. All the equipment in the facility areas are being inspected /tested by an outside agency.

Some of the safety measures carried out by the management to ensure prevention of occupational hazards is delineated below.

- All the hazardous material will load/unload safely and will use appropriate PPE's.
- Regular training to drivers to handle emergency situation during transportation of waste.
- Personal protective equipment are provided to all the
- Employees at placed at appropriate places.
- Provision of normal water for eye wash fountain and showers bath etc. would be made available in the facility premises.
- Manual handling shall be avoided up to the possible extent.
- D.G. set is also available which can supply power to fire pump in case of grid power failure.
- In addition to fire hydrant system, number of fire extinguishers (dry chemical powder, CO2, foam type etc.), and fire buckets are also installed at all the appropriate places within premises.

Generation and Disposal of Different Hazardous Waste

					Project Tenure				
Sr. No	Hazardous Waste	Category	Permissible Limit	Opening stock	Oct 21	Nov'21	Dec'21	Closing stock	Disposal Mode as per Authorization
1	Empty barrels / Containers Contaminated with hazardous chemical waste.	33.3	6690 Nos/Annum	617	30	22	17	686	Send to authorized supplier.
2	Empty bags with liners Contaminated with hazardous wastes/chemicals.	5.2	14750 Nos/Annum	440	25	16	14	495	Send to authorized supplier.
3	Construction waste.	35.3	172.8 MT/Annum	2 MT	0.3 MT	0.4 MT	0.1 MT	2.8 MT	Send To TSDF site
4	Used Oil.	5.1	0.5 KL/Annum	0	0	0	0	0	Disposal by Selling to registered recycler or reuse in plant as Lubricant.
5	Contaminated cotton rags or other cleaning materials.	5.2	3.6 MT/Annum	125 Kg	3 Kg	6Kg	4 Kg	138 Kg	Collection storage transportation & Disposal.

Hazardous waste Manifest System

The sender of the waste shall prepare seven copies of the manifest in Form 10 comprising of colour code indicated below and all seven copies shall be signed by the sender.

Copy number with colour code	Purpose
(1)	(2)
Copy 1 (White)	To be forwarded by the sender to the State Pollution Control Board after signing all the seven copies.
Copy 2 (Yellow)	To be retained by the sender after taking signature on it from the transporter and the rest of the five signed copies to be carried by the transporter.
Copy 3 (Pink)	To be retained by the receiver (actual user or treatment storage and disposal facility operator) after receiving the waste and the remaining four copies are to be duly signed by the receiver.
Copy 4 (Orange)	To be handed over to the transporter by the receiver after accepting waste.
Copy 5 (Green)	To be sent by the receiver to the State Pollution Control Board.
Copy 6 (Blue)	To be sent by the receiver to the sender.
Copy 7 (Grey)	To be sent by the receiver to the State Pollution Control Board of the sender in case the sender is in another State.

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Results and Suggestions for Further Development

In the carried-out research including visits to the projects of residential complexes "Mango Haven" it was studied how waste is generated on the construction site and how it is managed. By starting from the administrative facilities, the importance of creating the right "atmosphere" on the site was noticed, and how the idea of maintaining cleanliness on the workplace is reinforced there. Although there were seen some not particularly well cleaned indoor areas, in general the construction site is maintained in a clean shape and waste is efficiently collected. Moving further through the sites, various technological processes were observed, it was noted how and why waste is generated in each of them. The main positive and negative points are displayed in the Table below.

Waste origin	Positive points	Negative points	Comments
Administrative facilities	Clean work environment.	No waste sorting.	Lack of waste sorting is not as crucial, here waste would not classify as CW, but can set the aim for the whole site.
Groundworks	Use of natural features for later decorative purposes.		Example: At "Mango haven" boulders are used for street decoration.
Building frame	Use of precast elements;embedded concrete block walls.	Cast-on-situ frame.	Precast structures result in less overall waste output, no need for formwork, fewer
			mistakes in construction.
Roofing		Violations of the "top-to-bottom" work structure; Unclear cleaning responsibilities; Extra material loss from wall opening coverings.	"Top-to-bottom" work structure suggests finishing works to be done from top floors down for easier cleaning and waste collection.
Façade works	Balcony frame design flaw solution.	Mineral wool leftovers	"Wet" facades guarantee mineral wool leftovers generation
Site in general	Concrete slabs reuse; Wooden safety planks reuse; metal materials sorting.	Improper mineral wool material storage.	Reusing mentioned assets results in less unnecessary waste generation.
Design stage	Use of BIM in design and other stages.		BIM lessens the amount of design mistakes.
Others	Plastic garbage waste, Wooden Waste, E waste and chemical & oil waste		Handle properly

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As of now no efficient waste sorting is done on site, apart from

Waste avoidance through design, though is already practices still is not perfect, as the observed balcony frame issue shows that mistakes take place even with the help of BIM;

- Inert and non-inert waste separation could bring the benefit of partial waste disposal by backfilling;
- Material choice with less waste generation potential;
- Proper material handling and storage.
- Vaguely fixed officially, there is good potential for further development.

High level of worker control is a good advantage in promoting waste minimization and sorting. While other issues arriving from the waste contractor companies as there is virtually little to be done regarding proof of the legitimacy of waste disposal.

The main weaker CWM areas at CIL sites include lack of waste sorting in the administration facilities and other forms of worker separating accessible metal and putting it up for sale. Construction waste on sites is gathered unseparated into same containers and then disposed by the waste contractor company. The waste handling contractor provides reports regarding the disposal of waste but means of disposal lie beyond CIL responsibilities. construction sites present a high level of organization and subordination with good compliance with the safety requirements.

Although responsibilities regarding waste collection and cleanliness maintenance are education on waste sorting, using cast-on-situ design solutions, poor indoor cleaning and responsibility arrangements for contractors occupied with finishing works, improper material storage. These areas require foremost attention for improving waste management and implementing further developments. More thorough administrative control is required to address the mentioned issues.

The main ideas of proper CWM from the studied theoretical background are applicable in the studied cases:

V. CONCLUSION AND RECOMMENDATION

5.1 **Conclusion**

- Construction scale may play a significant role in some areas of material sharing like mentioned with the wooden plank safety barriers and concrete pavement. With the increase of projects scale the amount of assets like these ones increases and this may make it harder to track them, resulting in loss and later unnecessary waste creation.
- Studied reports show monthly unsorted waste amounts, costs for disposal and metal waste amounts. This information brings an understanding of generated waste amounts and the difference in waste generation between CIL projects in different cities. The values in these reports may serve as a background for further KPI (key performance indicator) development for better CWM evaluation.
- Waste must only be sorted for a direct purpose, so not to be pointless work. Before setting up a sorting system on site, material streams must be arranged and specific materials needing sorting must be determined. Waste collection and sorting falls into the hands of contractor workers who are already responsible for cleanliness maintenance and waste collection. In such way an accessible educating program that shows the purpose and results of waste sorting can be decisive.
- As already noted, CWM culture starts from the administrative facilities, the headquarters of the construction site, this way the education must start from maintaining a clear goal orientation, setting examples for the rest of the site.
- The method adopted was conducting a detailed study on the amount of waste produced in M/s CIL such as chemical/ oil Sludge, plastic and non-plastic. From the collected data, a feasibility study was conducted on various waste management operation such as storage, handling, segregation and transportation system. Objective of the project was to analyse the effectiveness of the current waste management in M/s CIL and to put forward a new and effective one.
- This project study shows me the different aspects of Hazardous Waste Management.
- Hazardous waste is generated from different process occurred in industry having different characteristics.
- Hazardous chemical and oil are to be sent to GPCB approved TSDF i.e. M/s Saurashtra Enviro Project PVT.LTD and Detox India PVT.LTD at Kutch (Samakhyali).
- After completion of the study, I found that Hazardous Waste is generated from industry is harmful to environment but impacts can be minimized by adopting proper handling and disposal practices.\

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- Clear responsibilities on cleanliness maintenance and waste collection are essential for effective waste sorting. Even though it is currently stated that each contractor must clean his workplace after he has finished the works, that is not clear enough on what waste must be collected or sorted. Clearly separating waste types needing to be collected can remove instances of dispute over who must clean what and is a first step towards effective waste collection and sorting on site.
- Thorough study on different material type waste generation will create a background for elaborating on further developments for putting the materials to use. A test sorting period can be used to determine precise amounts of waste by material. Gathered information can be then processed to create research backed proposals for business collaboration or find new uses for materials. In this study, identifying the risk factors faced by construction industry is based on collecting information about construction risks, their consequences and corrective actions that may be done

5.2 Recommendations

- When planning for future optimizations or changes it is always essential to track the progress and evaluate success. The obvious indicator of successful waste management is the decrease of waste by volume or weight. Anyhow, CWM development includes not only the prospect of reducing generated waste, but also finding new uses for the materials hidden within. These new uses offer business opportunities and in such a way measuring only waste volume reduction is not sufficient. Waste management deals with several stages like waste sorting, removal, disposal and often the final numerical values are known post factum, that's why lagging indicators are suitable in this case. In other words, the suggested KPIs are intended for measuring values and subsequently evaluating effectiveness from the past periods

Indian Regulation
Hazardous Waste (Management, Handling and Transboundary Movement) Rules 2016
Solid Waste Management Rule, 2016
Bio-medicate Waste (M & H) Rules,2016
Plastic Waste Management Rules,2016
Construction and Demolition Waste Management Rules, 2016
E-Waste (Management) Rules, 2016

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