REVERSE LOGISTIC NETWORK DESIGN FOR POST
CONSUMPTION PET DRINKING WATER BOTTLES AND
PLASTIC WASTE AT NAGPUR RAILWAY STATION

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ABSTRACT

Nagpur is the largest city in central India (2001 Census) and the second capital of the
state of Maharashtra. Nagpur’s population is 2,420,000; and is 13\(^{th}\) largest urban
conglomeration in India and 114\(^{th}\) largest city in world. It ranks as 143\(^{rd}\) largest urban
area in world in terms of population. With 7 platforms, Nagpur is a world class station,
and all the trains stop here for minimum 15 minutes. It caters to daily around 182 trains.
Daily around 1, 50,000 passengers use this station for boarding various local, passenger,
express trains. Considering huge passenger coverage by the IR one can easily predict the
daily consumption of water during the travel by the passenger. Even we estimate that
only 20 % of the passengers are using the PET bottles i.e. 30 thousands of drinking water
bottles are consumed daily by the travelers. After the use most of passengers throw away
the PET bottles which are littered in the tracks and on the platforms and subsequently
swept out and either burnt or thrown on the side of the track by the safaiwalas. This paper
aims at investigating the role of reverse logistic for effective distribution and recycling of
waste of PET bottles at Nagpur Railway Station so that this waste can turn it to be a
profitable business model for the Indian railway.

Keyword: Reverse Logistic, waste of PET water bottles

1. INTRODUCTION

Indian Railways (IR) is one of the largest and busiest rail networks in the world and an
important mode of public transportation in the country. Since their inception 154 years
ago, the Railways have contributed significantly to India’s transport needs and economic
growth. Today, Indian Railways ranks among the top five national railway systems in terms of size and scale and is poised to emerge as a world class railway system. The Nagpur railway station constitutes a very significant part of the transport and communication system in the city of Nagpur in Maharashtra. Many people from the rest of the country and abroad, visit the city of Nagpur to spend a vacation or on a work-related tour. For these frequent visitors to the city, the railways of Nagpur along with the airways and the roadways are of immense importance. The railways in Nagpur are important not only because the city is one of the tourist destinations of the country and the second capital of the significant state of Maharashtra, but also because of its prime location. Nagpur is well connected with network other parts of the country through Rajdhani, Shatabdi and Express trains. Due to the wide of trains, the stations experiences the huge quantity of waste and it mostly depends upon the numbers of trains originating and passing through the station and numbers of passengers handled. The details of the numbers of trains originating and passing through the station and numbers of passengers at three stations are summarized in Table 1. In all about 13 trains are originating from Nagpur station and about 156 trains passing through. The total numbers of passenger served at station are 1,50,000 per day.

<table>
<thead>
<tr>
<th>Total No. Of Trains</th>
<th>Originating Trains</th>
<th>Terminating Trains</th>
<th>Passinng Trains</th>
<th>Passenger Per Day</th>
</tr>
</thead>
<tbody>
<tr>
<td>182</td>
<td>13</td>
<td>13</td>
<td>156</td>
<td>1,50,000</td>
</tr>
</tbody>
</table>

2. WASTE GENERATION AND DISTRIBUTION SYSTEM AT NAGPUR RAILWAY STATION

The plastic wastes generated from the railway station are lacking proper collection, segregation, transportation, treatment, reuse and disposal of plastic waste. The important stakeholders of this waste generation system at railway stations are:
• Passengers • Platform & Vendors • Offices at station • Pantry cars• Waiting / Retiring Rooms • Dustbins • Rag-pickers • Kabadis

i. Passengers
The daily travelling passengers are the main source of waste generation at Nagpur station. Approximately 1, 50,000 passengers are travelling at this route. Considering the vast daily passengers at Nagpur, it becomes essential to generate the huge plastic waste at station. The throw away culture of these passengers causes the littering of Plastic waste, drinking water bottles, everywhere in and around the station.

j. Platform & Vendors:
Platform vendors are the major users for the plastic packaging containers for supply of feed materials to the passengers at platform. Passengers purchase the needful items from vendors in plastic containers. On consumption/ utilization of needful items, the plastic
containers in the form of plastic waste are thrown either in the designated dustbins or on platforms/ rails.

### Table 2. Numbers of Platforms and Vendors

<table>
<thead>
<tr>
<th>Station</th>
<th>Platform</th>
<th>Vendors</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nagpur</td>
<td>7</td>
<td>16</td>
</tr>
</tbody>
</table>

**ii. Offices at station:** Offices located at platform or station building also contributes in the system for generation of plastic waste.

**iii. Pantry cars:** The Indian Railway Catering and Tourism Corporation (IRCTC) are responsible for managing and supplying the entire catering services for the railways. The IRCTC has been using various types of plastic for packaging food items to the passengers. Trains like Rajdhani and Shatabdi have well maintained pantry and waste collection system within the trains. However, other trains (express trains) do not have proper collection system. This is because of non AC coaches, which results in the throw away culture of refuse from the open windows. The remaining plastic waste is found lying scattered all over the floor of train and lifted by rag-pickers as train reaches the final destination station.

**iv. Waiting/Retiring Rooms:** Nagpur railway station is having waiting rooms and retiring rooms for passenger and officers refreshment. Two types of waiting rooms are provided for passenger services, in which one is AC type and another is Non-AC type. During field study it is observed that, dustbins are provided in each waiting and retiring rooms but the generation of plastic wastes found to be practically negligible and cannot be considered as the source.

**v. Dustbins:** The primary collection points are the dustbins. There are two types of dustbins

i) Railway departmental dustbins located at some specified distance on the platform and cleaned by the railway employee at the designated interval

ii) the second type of dustbins are placed close to the vendor shops and cleaned by vendors only. The Railway departmental dustbins are of fixed size and open whereas vendor’s dustbins are of varying size and shape. The waste from these dustbins is emptied/ disposed at the railway collection centre located within the station area about 18 dustbins are available on Nagpur station.

**vi. Rag-pickers:** It has been observed that rag-pickers are involved in collection, transportation and disposal of plastic waste from railway stations. The rag-pickers found all over the rail/track in search of plastic bottles in railway station area. The majority of rag pickers are child labor and in the age group 10 to

**vii. Kabadis:** Each railway station has specific and well established Kabadis and they deals in post consumer collection of plastic waste. Hence, Kabadis are the important link between collection and disposal of plastic waste from railway stations. Sometimes the sorting of plastic material is done at the location of Kabadis itself. Kabadis sale sorted/ crushed plastic material (bottles) to the bulk buyers or recycled units. There are 4 Kabadis near railway station.
3. TOTAL PLASTIC WASTE GENERATION AT NAGPUR RAILWAY STATION

During the study it has been observed that plastic waste is following the route of solid waste or kabadis for reuse or disposal. The quantity of plastic waste generated at railway stations are summarized in Table 3. The quantities at stations vary from 600 kg to 950 kg per day. The plastic waste generation per capita is calculated based on the ratio of the total quantity of plastic waste generated to total number of passengers per day. The per capita plastic wastes at railway stations vary from 4 gm to 7.5 gms per person per day. The analysis of data has concluded that the average plastic waste generation at Nagpur railway stations is about 4.092 gm per person per day.

**Table 3: Plastic Waste Generation**

<table>
<thead>
<tr>
<th>Sr. No</th>
<th>Plastic Waste Source</th>
<th>Quantity</th>
<th>Percentage (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Platform Vendors</td>
<td>387.04</td>
<td>81.49%</td>
</tr>
<tr>
<td>2</td>
<td>Passengers/Unauthorized Vendors/Passing Trains</td>
<td>226.76</td>
<td>18.51%</td>
</tr>
<tr>
<td>Total</td>
<td></td>
<td>613.8</td>
<td>100%</td>
</tr>
</tbody>
</table>

**Table 4: Per Capita Plastic Waste Generation**

<table>
<thead>
<tr>
<th>Location</th>
<th>Number of Passengers</th>
<th>Total Quantity of Plastic Waste(Kg)</th>
<th>Plastic waste per Capita (gms)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nagpur</td>
<td>1,50,000</td>
<td>613.8</td>
<td>4.092</td>
</tr>
</tbody>
</table>

4. REVERSE LOGISTIC

During the last decade, reverse logistics has received increasing attention from both academic researchers and industrial practitioners. Serious and persistent environmental concerns and government regulations have created a motivation to pursue further research in this field.

**Definition and Scope of Reverse Logistic**

The Reverse Logistics Executive Council defines reverse logistics as “the process of planning, implementing, and controlling the efficient, cost effective flow of raw materials, in-process inventory, finished goods, and related information from the point of consumption to the point of origin for the purpose of recapturing value or of proper disposal.”
Thousands of kilograms of virgin plastics are used annually to manufacture PET bottles, yet only a small percentage of this material is recovered for reuse in new plastic products. As considering this case of waste generation at Nagpur railway station it is possible to implement a reverse logistics network for waste of PET bottle recovery and to couple with existing industries and technologies and thus to save these waste to go into the environment.

5. REVERSE LOGISTIC NETWORK FOR PLASTIC WASTE COLLECTION AT NAGPUR RAILWAY STATION

Reverse logistics was used to analyze the supply of input plastics in terms of quantity and quality. This means clustering small neighboring Railway Stations for synchronized sorted collection (there is a difference between small Railway stations, which already use sorted collection, and big Railway stations, where no sorted collection for plastics exists), and coordinating activities between larger Railway stations.

A graphical representation of the system within which this network operates can be seen by the map in Figure 1.

![Figure 1: Reverse Logistic Network For plastic waste collection for reuse and recycle and disposal](image)

This map displays the 21 source railway stations and designated consolidation points. Each source station was defined using a Railway map of the India railway. Attempts were made to minimize the ratio of circumference to area in each of the station while staying faithful to existing station economic regional boundaries. One major station (Nagpur Railway Station) within each generation station has been designated as a consolidation point Recycling Center. In the hypothetical system this Major Station would serve as the hub for all regional collection before any transcontinental transport. When possible, a centrally-located Station was selected for this role. In calculating transportation route lengths, measurements were taken to and from these points.
Possible types and locations of Recycling and receiving facilities are also indicated in Figure 3.1. These three locations all contain major Receiving centers. They are: Badnera, Chandrapur and Gondia. Nagpur is only site on this route which has both receiving as well as Recycling Facility. Finally, a range of consumption, receiving and Recycling facility sizes was selected using existing facility information as a guide. Distances between each consumption source point and recycling and receiving center (processor location), used for calculating route-length-dependent transportation costs, and can calculated on existing standard rate.

First summarize the current plastics collection, identification, and separation processes at Railway stations. Then, present an engineering approach for plastics recycling, based on characterization. Use the proposed reverse logistic Network for to introduce a sequence of steps to obtain used-plastic input data for recycling. Then consider the strategic factors to consider in Reverse Logistics include costs, overall quality, customer service, environmental concerns and legislative concerns. On the operational side, factors to consider are cost–benefit analysis, transportation, warehousing, supply management, remanufacturing and recycling, and packaging.

6. CONCLUSION
Due to rapid pace of urbanization there is an increasing demand of transport especially in railways. In this sector passengers are handled at Railway station. There are several environmental challenges; one of these is waste management specifically plastic waste management. Environment issues regarding plastic waste arise predominately due to the throwaway culture and lack of waste management system. Inadequate resources, in-appropriate technologies, management apathy and low efficiency of system are unable to give fruitful results. Undoubtedly, it is the habit of people and lack of infrastructure for management of solid waste. Problems have been identified in the collection, transportation and disposal system along with the quantified plastic waste at railway stations. The existing policies have not been able to provide any respite solution for associated problems. Indian Railway doesn’t have an effective distribution and management system for waste or garbage. Considering the huge demand of the water drinking bottles during the travel in coming year and at Indian rail there is need to be a scientific technique to overcome the problem of waste and garbage developed. With an efficient reverse logistic network it is possible to combine plastic bottle recycling with material production and product remanufacturing. These waste PET bottles may potentially be valuable inputs into a variety of industrial and manufacturing processes and by using a the proposed Reverse logistic network these waste can be used as a revenue generation mechanism and can be implemented all over Indian railway station ,which is also helpful for green environment.

REFERENCES