“SMART SOLUTION TO DESIGN SHIMLA AS SMART CITY”

A PROJECT

Submitted in partial fulfillment of the requirements for the award of the degree of

MASTER OF TECHNOLOGY

IN

CIVIL ENGINEERING

Under the supervision of

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to

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CERTIFICATE

This is to certify that the work which is being presented in the project report titled **"SMART SOLUTION TO DESIGN SHIMLA AS SMART CITY"** in partial fulfillment of the requirements for the award of the degree of Master of Technology in Civil Engineering and submitted to the Department of Civil Engineering, Jaypee University of Information Technology, Waknaghat is an authentic record of work carried out by Rahul Prashar (152610) during a period from July 2016 to December 2016 under the supervision of Mr. Anirban Dhulia and Mr. Santu Kar Assistant Professors, Department of Civil Engineering, Jaypee University of Information Technology, Waknaghat.

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ABSTRACT

Urbanization is the integral part of the development process, especially for those nations who are rapidly growing. It brings about the social transformation, from traditional societies to present modern urban communities. Recently government launched an ambitious programme for the development of urban and rural areas by creating 100 smart cities. These smart cities is a collaboration of technology into strategic approach of sustainability. The programme will provide the city where information technology is the principal infrastructure and the basis for providing the essential services to the residents. The need of the smart city arises with the huge migration of the rural population to cities. The project focuses on the contributions of the techniques in accordance to civil engineering like solid waste management, transportation system. The solid waste management plan with emphasis on the putting the waste to beneficial work. The breakdown of waste generated in huge amount can be utilised for generating energy. The pre- occupied landfill can be cleared and be put to use for other work.

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CHAPTER 1

INTRODUCTION

1.1 SMART CITY AND ITS CHALLENGES

The economy of every nation depends on the development of its cities. In India approximately 31% of the population comes from urban society and gives a huge contribution of about 63% to Indian GDP. With the expansion in the human population in the years to come, India requires to accommodate the maximum with accommodation and takes the Indian GDP to the hike of 75% by the year 2030. Thus the development at every level like physical, social, institutional and economical infrastructural is required. The very important aspect lies in providing better lifestyle to the nation with quality investments. Therefore, the idea with improved city under the project "smart city" is just the beginning of the new era.

1.1.1 Smart city - A designed city

A question that comes to every mind what is a smart city? A well-defined answer is not found yet, still it carries a lot many variations with itself. The thought of the smart city is influenced by a lot of mind set of the welcoming society, reformed administration, the knowledge of the concepts and many more. The concept of the smart city means differently to the different people. A smart city have different view point in India, to any other country such as Europe. As such no new way of fully defining the smart city is available.

The imaginary picture of smart city consist of a long wish list of development with huge infrastructural facilities. A proper guidance across from every sphere would render a notable helping hand to the success of the mission of smart city. To live up to the aspiration of each individual, the proper growth is required at physical, social, institutional and economical grounds. The overall growth aims at the developing the entire ecosystem that stands on the four aspects as stated above. Although this in fact is a long term program, which aims at improving the core infrastructure of the city providing convenient and clean life style to life. It ensured the safeguard of the nature and avoiding any harm on environmental aspect. The objective of the

smart city is to provide the improved life with sustainable environment. The focus of the program lies in providing the better infrastructure, with the commendable "SMART SOLITIONS." The idea of the smart cities revolve around the compact areas, creating a reliable plans as a source of aspiration to the people. The concept of smart city is indeed an appreciable idea of the government. The success of this project would be source of employment as well can be set as a example to create more smart cities.

1.1.2 Core essential element of smart city:

I. Affordable accommodation to the increasing urban population.
II. Regular water supply
III. Improved sanitation and solid waste management
IV. Efficient transportation
V. Assured electricity.
VI. Health care centers.
VII. Digitalization with connected IT robust.
VIII. Sustainable environment.
IX. Safety and security of the citizens.

1.1.3 Diverse features:

The land used is promoted in accordance to area based developments as per 'unplanned areas' used up as per a range of compatible activities and land uses close to one another in the way utilizing the unused land. The smart city ensured some flexibility in land use and adopting the laws to provide protection as well. The plan includes walkable localities with less congestion, air pollution and proper local economy, promote interactions and ensure security. The road safety will be a topmost priority with the network created not only for vehicles and public transport, but ensuring safety of pedestrians and cyclists, and necessary administrative services are offered within walking or cycling distance.

Parks, playgrounds and recreational spaces are preserving and developing open spaces, to enhance the quality of life of citizens, reduce the urban heat effects in Areas and generally promote eco-balance. - Increasingly rely on online services to bring about accountability and transparency, especially using mobiles to reduce cost of services and providing services without having to go to municipal offices form e-groups to listen to people and obtain feedback and use online monitoring of programs and activities with the aid of cyber tour of worksites thus making governance citizen-friendly and cost effective.

1.2 SCOPE OF THE WORK:

Main scope of this study is to investigate the different feature of smart city in hilly region and to find out the different step taken to develop Shimla as smart city and also to suggest different technique or strategies for smart city in Shimla. In year 2015 the ministry of urban development selected Dharamshala as the city to be developed as smart city. In the race of selection for smart city Dharamshala was considered to be more appropriate as compare to Shimla for the consideration. In this study I am going to highlight certain viewpoints which can be taken for the development of Shimla as smart city if in future if Shimla gets the opportunity to be designed as the smart city.

1.3 OBJECTIVE AND GOALS:

Although there are various methods/ techniques for development of smart city. It basically depends upon assistance of administration power and welcoming nature of local people etc. but in this I am going to highlights those techniques which falls suitable in accordance to civil engineering point of view. Likewise ministry of urban development gave the suggestion of including video crime monitoring, to certain extend it shows relation with engineering but main it is the function of police administration to focus on the places with the urgent need for the CCTV cameras with respect to the population of the place to check the increasing crime. Therefore I am going to focus on the techniques in accordance to civil engineering like solid waste management, transportation system, retrofitting and renovation of heritage building etc.

CHAPTER -2

LITERATURE REVIEW

Based on the combination of different disciplines in engineering (Geographic Information Systems (GIS), combinatorial optimization), and utilizing the importance of municipal wireless access networks that leads to smart ways of improving the management of cities. It implement that the capability of transmitting information to the Internet is an intelligent solution may cover the extra expenses for maintaining a system for a smart city. Accepting smart city as Providing Urban Amenities in Rural Areas' (PURA), was to bring to the population in villages, the facilities of the city without actually needing to move there. It emphasis on talks of three basic connectives – physical connectivity like roads and railways, electronic connectivity like Telecommunications, the internet and knowledge, which will then result in economic connectivity; this will empower villagers, giving them sufficient employment opportunity. (Jose and Michael 2015) [3] Increased efforts have been made for the improvement of technology and innovation considering 30% of Co_2 emission by the transport sector. Under the SMILE project 2015.

This project pursues innovative 'green' and cost effective solutions, addressing the goal of green and smart urban development. It improves economical, operational, environmental and social perspectives. The two digital things that can accelerate a city become a smart city. The first is the digital-city strategy and the second is digital initiative comes from the community. Digital-city strategy offers new ways for government and developers to build infrastructure and services more efficient. Digital-city strategy with IP network infrastructure, e-government services, digitalization process, and planning system in urban areas, transportation, healthiness, education, utilities, and buildings will strengthen the community .(Paul Varghese, 2015) [2].

Developing smart city requires many types of information, including geospatial information. Several method can be used to develop useful geospatial information.

Several method can be used to develop useful geospatial information, i.e. terrestrial survey, photogrammetry, remote sensing using very high resolution satellite imagery. **(**Navarro and Roca, 2015) [1] Green open space is the most important factor to be consider in the smart city. The population growth trend to the reduction of open space in the urban area both green open space and non-green open space. Increased urbanization lead to depletion of high percentage of natural resources consumption and waste generation, various initiatives proposing different framework approaches for Smart City concept that focus on the need for smart infrastructures, including smart energy grids and smart mobility systems. Taken this into consideration, project "Sus City" project takes an integrated and application oriented research. The importance of an intelligent transportation system in smart cities, the present studies propose that there is an urgent need to assemble, disseminate all the available information and academic and commercial ICT proposals to improve urban mobility, to make an active and exciting attempts to revitalize the city (Retno and Susanti, 2015) [4].

CHAPTER-3

SOLID WASTE MANAGEMENT OF SHIMLA CITY

Waste generation is an inevitable consequence of industrialization and urbanization. With increasing world population and standards of living, it is not amazing that the quantities of wastes have grown rapidly worldwide in recent decades. The explosive growth in population and sustained drive for economic progress and development has resulted in a remarkable increase in the quantity of solid wastes from different processes viz., domestic process, industrial processes in our country over the last couple of decades. Most urban areas in the country are plagued by acute problems related to solid waste management over the years. There has been a progressive decline in the standard of services with respect to collection and disposal of Municipal Solid Waste (MSW). In many cities, half of the solid waste generated remains unattended, giving rise to unsanitary conditions. In order to manage urban waste Scientifically, Ministry of Environment & Forests, Govt. of India has promulgated Municipal Solid Waste (Management & Handling) Rules, 2000. The honorable Supreme Court has set certain time frame to comply these rules. However, due to lack of infrastructure, technical manpower, etc, these deadlines have not been fulfilled.

In order to fructify investments for urban development, a national level initiative Jawaharlal Nehru National Urban Renewal Mission (JNNURM) has been set up to bring together the State Governments and enable ULBs to catalyze investment flows in the urban infrastructure sector. Shimla is one of the city planned under JNNURM for urban development. Solid Waste management is part of urban development. In this chapter we will discuss effective solid waste management for providing clean and hygienic conditions in the cities and reduce the quantity of solid waste, recovery energy from solid waste of Shimla.

3.1 PROFILE OF CITY:

Shimla is India's one of the most popular and biggest hill-stations, is located in the northwest Himalayas in Himachal Pradesh. It is located at latitude of 21°13'N and longitude of 81° 26' E,

having an altitude of 2130 - 2205 meters above mean sea level. In shape, it has been described as an irregular crescent. It is 88 kilometers from Kalka. It is spread over an area of 9950 Hectares along with its commanding position. Location map of Shimla in India is shown in figure 3.1 and location of different tourist center are shown in figure 3.2.

Figure 3.1 Location map of Shimla in India

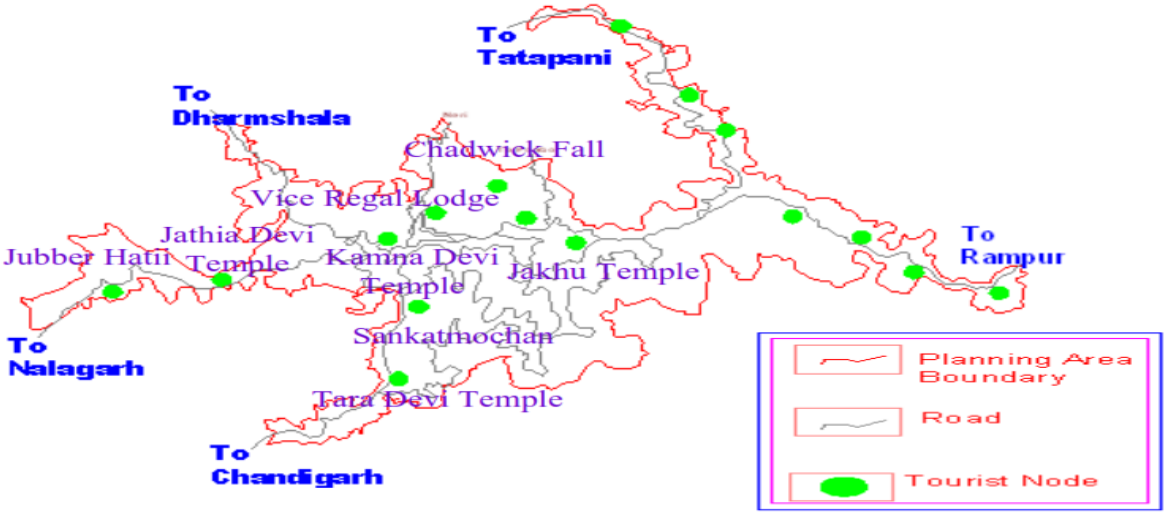

Figure 3.2 Location of different tourist center in Shimla.

3.2 DISTRIBUTION OF LAND AREA IN SHIMLA:

Table 3.1 Distribution of land area Shimla

Settlement	Area in hectare	Percentage
M.C. Shimla	2207	22

S.A. Ghanahatti	1647	18
S.A. Kufri	3173	31
S.A. Shoghi	2923	29
Total	**9950**	**100**

3.3 DEMOGRAPHY:

The population of Shimla has increased from 129827 persons in 1991 to 174789 in 2001, recording a decadal growth rate of 34.63 percent (Source: Census report obtained through Shimla Municipal Corporation office). Based on the census data for the years 1971, 1981, 1991, 2001, 2011 populations for the next 20 years have been projected using the exponential growth series as shown in Table 3.2, 3.3 and 3.4 below.

3.3.1 Fixed population

Table 3.2 Fixed Population

S.No.	Year	Population
1	1971	72870
2	1981	95851
3	1991	129827
4	2001	174789
5	2011	233000
6	2016	270000
7	2021	312000
8	2026	361000
9	2031	415200
10	**2036**	**477500**

3.3.2 Floating population

Table 3.3 Floating Population

S.No.	Year	Population
1	1971	23459
2	1981	30000
3	1991	40000
4	2001	56000
5	2011	73689
6	2016	88106
7	2021	96116
8	2026	120145
9	2031	138100
10	**2036**	**158000**

3.3.3 Total Population:

Table 3.4 Total Projected Population

S.No.	Year	Fixed Population	Floating Population	Total
1	2011	233000	73689	306689
2	2016	270000	88106	358106
3	2021	312000	96116	417116
4	2026	361000	120145	481145
5	2031	415200	138100	553300
6	**2036**	**477500**	**158000**	**635500**

3.4 ESTIMATION OF MUNICIPAL SOLID WASTE GENERATED IN SHIMLA:

For devising an appropriate solid waste management system in a town, it is important to know the quantity and characteristics of solid waste generated. To assess the quantity and characteristics of solid waste generation in Shimla, field investigation studies were carried out. This included verification of existing intermediate waste storage systems, quantity of waste being brought to the existing waste processing site and waste collection efficiency as discussed with officials of MC, Shimla and NGOs involved in primary waste collection in Shimla.

For quantifying MSW generation in Shimla, per capita waste generation factor was arrived through following steps:

a) Solid Waste management Manual prepared by Ministry of Urban Development, Govt. of India was referred and per capita generation factor corresponding to the present population of Shimla is being identified.
b) Based on the data on waste generation for the year 2013, 2014, 2015 as given by MC, Shimla, Per capita waste generation factor is being calculated using projected population for corresponding years.
c) Based on the waste collection efficiency concluded through discussions with MC, Shimla and NGOs involved with solid waste management in Shimla, Per capita waste generation factor is being estimated.

3.4.1 Based on Information provided in Solid Waste Management Manual:

As per the Manual on Solid Waste Management, Ministry of Urban Development, Govt. of India, following are the rate of waste generation as given in table bellow

Table 3.5 Per Capita Waste Generation as per manual on solid waste management by Ministry of urban development, Govt. of India.

Population Range	Average per capita waste generation (kg/day)	Remarks
<10,000	0.21	
10,000-50,000	0.21	

50,000-1,00,000	0.25	
1,00,000-2,00,000	0.27	
2,00,000-5,00,000	0.35	
>5,00,000	0.5	0.6-0.65 kg /day is observed in some

The projected population of Shimla for Year 2036 (Refer table 3.2.3) is 635500. Therefore, per capita waste generation factor is taken as 0.6 kg/day

3.4.2 Based on information provided by MC Shimla:

Based on the information provided by MC, Shimla, per capita waste generation factor for Shimla has been calculated as given in table 3.6.

Table 3.6 Per Capita Waste Generation as per information provided by MC Shimla

Description	Year 2013	Year 2014	Year 2015
Quantity of waste generation as given by MC, Shimla(in tonnes)	197	206	212
Total Population	324354	333564	343035
Per Capita waste generation factor	0.60	0.61	0.61

The per capita waster generation factor has been estimated as can be seen from the table above is between 0.6 -0.61Kg/day.

3.4.3 Based on the total quantity of waste reaching the existing waste processing site (year 2015):

According to MC Shimla about 134 tones waste quantity per day reaches the existing waste processing site. Based on the discussion with various NGOs working in Shimla and MC, Shimla officials, it has been concluded that the existing waste collection is only 65%. The total waste generation then can be estimated as (134 /0.65 T/day) or 206 T/day.

Per capita waste generation factor = 206000/343053 = 0.6004 Kg/capita/day

3.4.4 Design Per capita waste generation factor:

For design purpose, higher per capita waste generation factor has been considered. As per capita generation factor of 0.65 kg/day is considered here. Based on this factor, the waste generated during the year 2015 and projected waste generation for the year 2021, 2026, 2031 and 2036 in Shimla is estimated using corresponding projected population figures as given in Table 3.7.

Table 3.7 Total waste quantity in TPD for next 21 years

Year	Population	Total waste quantity in TPD
2016	358106	233
2021	417116	271
2026	481145	313
2031	553300	360
2036	635500	413

Out of the total waste generation, waste generation from Sabzi mandi, fish/meat market has been separately quantified during field studies and are as given below:

(i) Sabzi Mandi: 1 T/day

(ii) Fish/Meat Market: 35 – 40 Kg/day

(iii) Chicken Market (comprising of feathers): 1 T/day

In addition to total waste generation mentioned above, Waste is also generated through constructional activities and natural slips which have been estimated to be around 230 Tonnes/day (Source: 'Shimla Vision Document', Municipal Corporation, Shimla)

3.5 CHARACTERSTICS OF MSW GENRATED FROM SHIMLA:

As a result of scavenging, handling, wetting, drying and vibration while moving from source to disposal site in collection vehicle, significant changes in the density of solid waste occur. Normally the moisture content in MSW ranges from 20% to 45%. In context of Shimla, Municipal Solid Waste (MSW) is generated from several different sources, such as: Household waste: Garbage including food wastes (organics / tins / cans / glass etc.), paper, furniture,

crockery, sweepings, garden/yard waste, fireplace ash etc. Commercial: similar to household waste, produced from offices, shops, restaurants etc. Drain desalting Waste: Solids from small and large drains carrying the wastewater/ storm water Construction and Demolition Waste: Bricks, brickbats, concrete, asphalt material, pipes and other construction material Institutional Waste: Similar to household waste plus hazardous, explosive, pathological and other wastes which are institution specific (example hospitals and research institutes).Knowledge of density of the waste is essential for the design of all elements of the solid waste management plan. The density of MSW in different cities in India has a high initial value and varies over a range of 300-500 kg/m. As Shimla is tourist place, more packaging material is expected in the mixed waste. Therefore, lower bulk density value i.e. 300 Kg/m^3 is considered for Shimla for all design purposes. Normally the moisture content in MSW ranges from 20% to 45%. Further MSW samples from different sources like Sabzi mandi, purely residential area like Army Camp and a composite sample were collected during field studies and were analyzed for physical and chemical characteristics. The results of MSW samples are as given below in table 3.8.

Table 3.8 Physical Characteristics of MSW analyzed from different sources

S.No	Components	Percentage (%)
	Sabji Mandi Area	
1	Paper	4
2	Rubber, Leather, Synthetics	0.56
3	Glass	0.26
4	Metals	0.12
5	Total Compost able	87.67
6	Inert	7.39
	Purely Residential area (Army Colony)	
1	Paper	12.77
2	Rubber, Leather, Synthetics	3.56

3	Glass	4.72
4	Metals	0.86
5	Total Compost able	69.67
6	Inert	8.42
	Composite MSW sample	
1	Paper	14.20
2	Rubber, Leather, Synthetics	2.43
3	Glass	3.31
4	Metals	0.84
5	Total Compost able	66.45
6	Inert	12.77

3.6 EXISTING MSW COLLECTION SYSTEM:

Shimla generates about 206 tons of MSW per day. At present, MC, Shimla is managing MSW generated from MC area and SADA areas of Dhalli, Kasumpti and Tutu only. Total waste generation from these areas is around 60 tons per day. Out of which tons per day (65%) is collected and processed at the existing waste processing site in Darni ka Bagicha. For collection of waste, MC, Shimla has provided dustbins and dumper placer containers at different places in the city. However, only the Mall and the Ridge areas appear cleaner. Remaining areas predominantly residential and commercial localities namely, Subzi Mandi, Lower Bazaar, Jakhu, Kaithu, Sanjauli, Kasumpti, Boileauganj and Summer Hill witness acute solid waste problem. Sanjauli locality is a dense residential area and is not under effective management of solid waste system causing environmental problems and nuisance to residents. A few local NGOs are also involved in collection of waste from doorsteps for a reasonable amount of Rs. 35/- as collection fee per household. As more than 80 % areas are not

accessible by vehicles, therefore it is imperative to enforce the Door-to-Door collection scheme strictly.

3.6.1 Collection of waste from residential & commercial areas:

Presently, in Shimla door-to-door waste collection system is operational in only 2300 houses out of a total of around 40,000 households in Shimla. This accounts for around 8% of the total number of houses. In remaining 92% of the area, residents directly place their waste in nearest concrete dustbins or dumper placer bins placed by MC, Shimla. Door to door waste collection is being carried out by three NGOs in Shimla, namely, Green Carpet, Sulabh International, Pragati Sudhar. Green Carpet also collects waste from commercial areas like Mall road, Subzi Mandi.the green carpet vehicle picking up waste from commercial area as shown in figure 3.3.

3.6.2 Segregation of waste:

No segregation of waste is followed at source, however, at the existing waste processing site in Dharni Ka Baghicha, rag pickers pick the recyclable material from the waste. Rag picker picking up recycle material from waste as shown in figure 3.4.

Figure 3.3 Green carpet vehicle picking up waste from commercial area in Mall road.

Figure 3.4 Rag pickers pick the recyclable material from the waste

3.6.3 Street Sweeping & Drain cleaning:

Street sweeping is carried out daily within central Shimla like The Mall, Ridge, Lower Bazaar, Subzi Mandi, Meat/fish market. At other places street sweeping is not done on Saturday and Sunday and public holidays. Collection is also carried out through street sweeping. The total length of roads in MC, Shimla area is 142 km. Street sweeping in MC, Shimla is carried out through 405 sanitation workers of MC. The road length covered per sweeper is about 350 m as against the national average of 1-1.5 km. The collection is carried out using Suphli and baskets and transportation of street sweepings to nearest community bin is carried out using nylon bags. Sweeping is also carried out through private sweepers on Sundays and holidays in the heart of the city i.e. Mall Road, Lower Bazaar, Sabji Mandi, Lakkar Bazar etc. The sanitary workers while sweeping the roads/streets as shown in figure 3.5 removes the waste thrown on the street and places them in a basket/ pans (tasla) and subsequently transfers them to the nearest dumper container or concrete dustbin.

Figure 3.5 Sweeper cleaning the Vegetable markets with long handled booms and then places their waste into the dumper container.

3.7 EXISTING WASTE STORAGE SYSTEM:

Waste collected by NGOs through door step collection system is either placed in the nearest concrete dustbin or nearest dumper container. Similarly, waste collected through street sweeping is placed in these dustbins. There are about 206 dumper placer container placed in Shimla. Out of the total, 142 containers are placed in MC area and 64 dumper containers in SADA areas. In addition to the above there are 93 small dustbins placed for disposal of waste by residents in Shimla. A concrete box constructed near mall road Shimla as shown in figure 3.6.

Figure 3.6 A concrete box constructed near mall road Shimla.

3.8 EXISTING BIO MEDICAL WASTE COLLECTION, HANDLING AND MANAGEMENT SYSTEM:

There are seven Health Care centres and 39 nursing homes, dispensaries and clinics in Shimla The biomedical waste generated from these Health Care centres is stored separately in different colour coded bags and domestic waste is stored in buckets. The domestic waste is placed in the nearest dumper container by safai karamchari of the health Care Centre. A NGO called 'Green Carpet' is engaged by MC, Shimla to collect and transport Bio-medical waste in covered Cargo-Maruti Van to the centralized Incinerator facility in Shimla. Colour coded bags are used for storage of biomedical waste shown in figure 3.7 and Centralized Incineration Facility for Biomedical waste located at Shimla s shown in figure 3.8.

Figure 3.7 Colour coded bag use for storage of biomedical waste.

Figure 3.8 Centralized Incineration Facility for Biomedical waste.

3.9 EXISTING WASTE PROCESSING AND DISPOSAL FACILITY:

Existing waste processing site is located on the valley side of bye pass, at Darni- ka-Bagicha, lalpani, Shimla. The site is about 5 Km from central Shimla and has an area of around 1200 Sq. meter. The dead animal is also brought to this site.

Bioconversion Process followed at Darni-ka-Bagicha: The solid waste is unloaded in the premises of the plant, and then stacked as heaps. Unauthorised rag pickers at the site also do primary segregation of recyclable material. A specific chemical, manufactured by the Excel Industries is sprayed on the heaps to accelerate the bacteriological decomposition to reduce the volume and to control odour nuisance. The processed heap is sorted manually for removal of glass, stones and then allowed on to the sieves for separation of sand, dust and other inorganic

substances. Turning of waste using JCB at Darni Ka Baghichha as shown in figure 3.9. Heaps of waste at dumping site as shown in figure 3.10. Segregation of rejects from bio-converted compost as shown in figure 3.11 .These screened materials are allowed on to the magnetic separators for segregation of iron pieces and the finely screened waste is loaded on the grinders for generation of organic manure. Rejects of Compost Plant thrown on the adjacent valley as shown in figure 3.12.

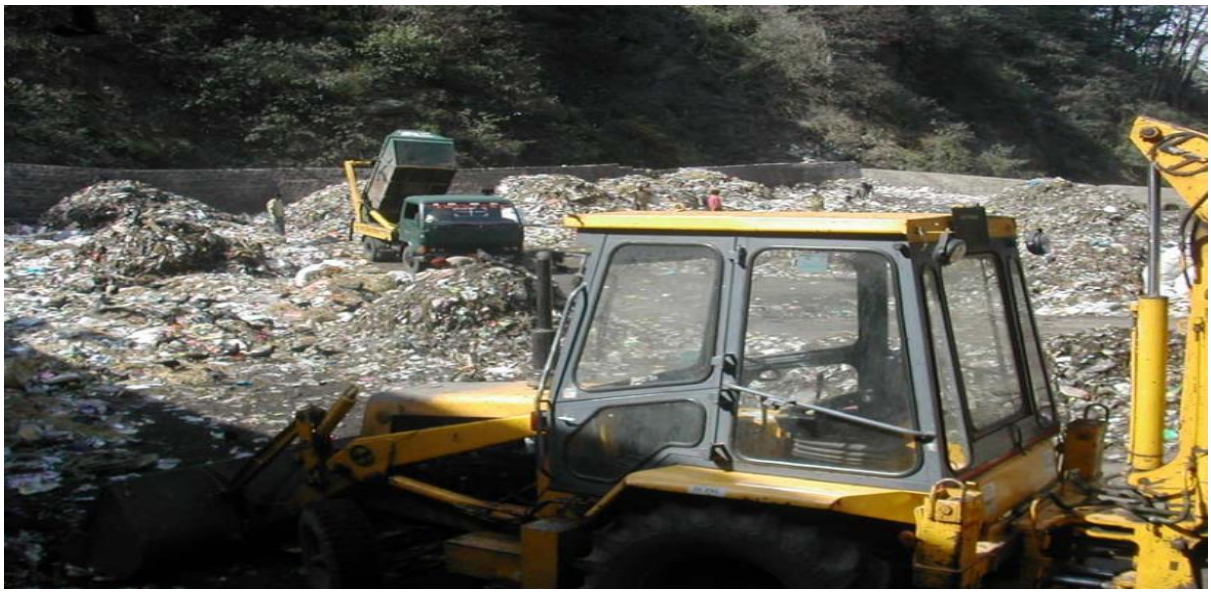

Figure 3.9 Turning of waste using JCB at Darni Ka Baghichha.

Figure 3.10 Heaps of waste at dumping site.

Figure 3.11 Segregation of rejects from bio-converted compost.

Figure 3.12 Rejects of Compost Plant thrown on the adjacent valley.

3.10 PRESENT BUDGET FOR SOLID WASTE MANAGEMENT:

MC, Shimla does not maintain statement of account exclusively for solid waste management. However during discussion with the MC personnel, they indicated that budget for this head was about Rs.12 core during the year 2014-15 which constitutes about 27% of total municipal annual budget.

About 82% of the expenditure is on manpower and balance 18% on fuel, vehicle maintenance, materials and others. While the major cost component (77%) is sweeping operation, the transportation contributes to 12% cost. Presently no costs are incurred towards processing and disposal. The capital cost towards SWM services is met from current revenues and borrowings (Source: Municipal Corporation, Shimla). The cost of solid waste management is approximated

to about Rs 2600 per tons of waste, which is very high compared to national average (Rs 1000-1300 per tonne in plains).

3.11 GENERATION OF BIODEGRADABLE AND NON-BIODEGRADABLE:

Table 3.9 Generation of Non-Biodegradable waste to land fill in TPD.

Year	Total Population	Total waste quantity TPD	Biodegradable Waste in TPD (approx. 65%)	Rejected from waste processing plant (30%)	Non-Biodegradable waste to the land fill
2016	358106	233	152	45	126
2021	417116	271	177	53	147
2026	481145	313	204	61	170
2031	553300	360	234	70	195
3036	635500	413	269	80	224

Table 3.10 Yearly generation of Non-Biodegradable waste to fill in TPA.

Year	Population	Total waste quantity TPD	Biodegradable Waste in TPD (approx. 65%)	Rejected from waste processing plant (30%)	Non-biodegradable to the land fill in TPD	Non-biodegradable to the land fill in TPA
2016	358106	233	152	45	126	45990
2017	369196	239	155.35	46.605	130.255	47543.08
2018	380630	247	160.55	48.165	134.615	49134.48
2019	392418	255	165.75	49.725	138.975	50725.88
2020	404571	262	170.3	51.09	142.79	52118.35

2021	417116	271	177	53	147	53655
2022	430018	279	181.35	54.405	152.055	55500.08
2023	443336	288	187.2	56.16	156.96	57290.4
2024	457066	297	193.05	57.915	161.865	59080.73
2025	471221	306	198.9	59.67	166.77	60871.05
2026	481145	313	203.45	61	170.55	62250.75
2027	496046	322	209.3	62.79	175.49	64053.85
2028	511408	332	215.8	64.74	180.94	66043.1
2029	527246	342	222.3	66.69	186.39	68032.35
2030	543575	353	229.45	68.835	192.385	70220.53
2031	553300	359	234	70	195	71175
2032	570435	370	240.5	72.15	201.65	73602.25
2033	588101	382	248.3	74.49	208.19	75989.35
2034	606315	394	256.1	76.83	214.73	78376.45
2035	625092	406	263.9	79.17	221.27	80763.55
2036	635500	413	269	80	224	81760
Total						**1324176**

3.12 REQUIRED CAPACITY OF SLF:

From table 3.10, the quantity of MSW to be disposed in 21 years period = 1324176 tones

Bulk density of the compacted MSW (assumed) = 0.9 t/m^3

Volume of waste to be disposed during 20 years (2016-2036) =1191758 m^3

CHAPTER- 4

SWEDISH WASTE MANAGEMENT

Preventing the creation of waste is the first step in the waste management. It is the focus of both Swedish and European waste legislation. The objectives are ::

I. Waste prevention
II. Reuse
III. Material recycling
IV. Other recycling, e.g. energy recovery
V. Disposal.

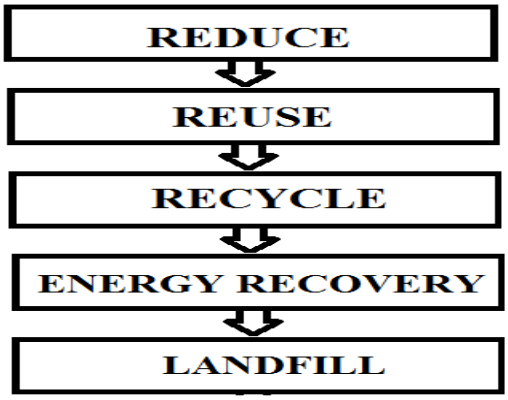

Figure 4.1 Basic concept adopted by Sweden Govt.

4.1 WASTE PREVENTION:

The Environmental Protection Agency is responsible to reduce the amount of waste and focuses on four waste streams that have a major environmental impact. Textiles, food, electronics and construction and removal of waste. Targets was set by the EPE of Sweden is the quantity of waste going to landfill, not including mining waste, must be reduced by at least 50 per cent by 2005 along with Zero waste vision. Some Interim targets was set by the EPE of Sweden:

I. The quantity of waste going to landfill, not including mining waste, must be reduced by at least 50 per cent by 2005, as compared with 1994.

II. Long-term vision ”Zero Waste”

Confidence is essential if the progress achieved is to be maintained. The total quantity of waste must not increase, and maximum possible use must be made of the resource that waste represents, while at the same time minimizing the impact on, and risk to, health and the environment. Reduced landfilling and increased recovery and recycling can largely be achieved by household sorting of waste at source.

4.2 REUSE:

Facilitating the prevention and reuse work of the municipalities. European Week for Waste Reduction”, which is also supported by the Swedish Environmental Protection Agency. The municipalities to collaborate on reuse at recycling centers with various charity organizations with aim at runs a project for one week in November when activities, aimed at reducing the amount of waste and the quantity of hazardous substances in waste are arranged all over Europe. . The project runs till 2016.

4.3 RECYCLE:

Material recycling plays a key role in a sustainable society. Waste must be viewed as a resource, and handled carefully. Material recycling means that separated materials can replace other production or construction materials. This can also leads to energy savings. Interim targets was set:

1. 50 per cent of household waste is to be recycled by recovery of materials, including biological treatment at least by year 2010.
2. Food waste from households, restaurants, institutional catering and shops which contributes about 35 per cent is to be recycled by biological treatment by 2010.
3. By 2010 food and similar waste from food manufacturing facilities etc are to be recycled by biological treatment. This target applies to waste arising without being mixed with other waste, whose quality renders it suitable for use as fertilizer after treatment.

4. Phosphorus compounds in sewage are to be recycled for use on productive land contributing about 60 per cent.
5. There should also be information on properties of chemicals handled in the market. Information on chemicals handled in large quantities or considered to be particularly hazardous should be available.

Sweden has one of the best recycling rates in the world, with an almost 50 percent material recycling rate. The result is that less than 2 percent of waste ends up in landfills, and the remaining 48 percent is converted into energy. Material recovery comprises recycling whereby other manufacturing or construction materials are substituted. Kinds of waste, such as ash and excavated materials, may be suitable for use as ballast in road building, where it can replace gravel and crushed rock. The quantity of household waste undergoing materials recovery is increasing forall types of material except refrigerators and freezers. Scrap, recycled paper and recycled plastics can replace a certain amount of new raw materials in manufacture. Recycle of MSW in Sweden till 2010 is shown in figure 4.2. And Amounts of packaging and paper collected (tones) from households for material recycling 2013 is shown in table 4.1.

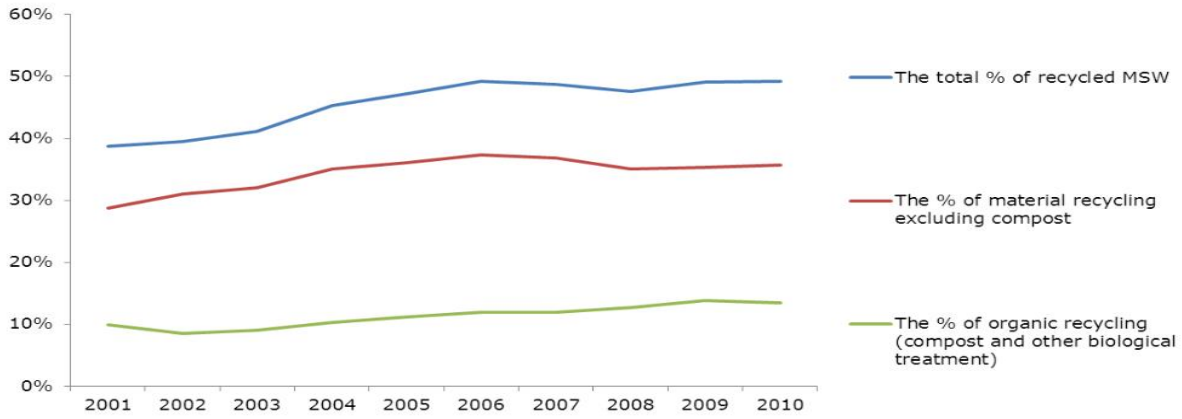

Figure 4.2 Recycle of MSW in Sweden till 2010

Table 4.1 Amounts of packaging and paper collected (tones.) from households for material recycling 2013.

Paper	332,780
Paper packing	128,880

Metal packing	16,530
Plastic packing	53,840
Glass packing	188,550
Total	**720,580**

4.3 WASTE TO ENERGY (ENERGY RECOVERY):

The efficient waste management in Sweden, the vast majority of this household waste can be recovered or reused. Over two millions ton of household waste is treated by waste to energy in Swedish plants every year. These plants incinerate a similar quantity of waste from industries as well. Waste incineration provides heat corresponding to the needs of 810,000 homes, around 20 per cent of all the district-heating produced. It also provides electricity corresponding to the needs of almost 250,000 homes. Waste to energy is a well-established source of energy in Sweden. The first incineration plant started operation in during the later part of the 1940s, the district-heating network was expanded in expanded in connection with the extensive construction of new buildings following the Second World War.

4.3.1 Environmental benefits of waste to energy:

Waste should be managed based on its properties, and this means that there is no standard solution for choosing the treatment method. The different methods material recycling, biological treatment, and waste to energy must be combined to achieve the best results. The choice of treatment method varies based on type of waste, local and geographical conditions and how well the waste is source separated. When all the factors are considered, the objective is the optimum environmental and social benefit. The waste generated by households, industries and other activities reflects our consumption habits. . Hazardous substances found in commodities and products persist when the products become waste. This places tough demands on all waste management, so that harmful substances are not spread. During incineration, many harmful substances break down and the residual substances are bound in ash, which makes them easier to control, handle and recycle.

Waste incineration in Sweden produced as much energy in 2007 as 1.1 million m^3 of oil, which reduces Co_2 emissions by 2.2 million tons per year, as much as 680,000 petrol-powered cars emit in a year.

The waste sector will reduce its emissions of greenhouse gases by 76 per cent during the years 1990-2020, according to the Climate Committee's forecast.

Waste incineration in Sweden produced as much energy in 2007 as 1.1 million m^3 of oil, which reduces Co_2 emissions by 2.2 million tons per year, as much as 680,000 petrol-powered cars emit in a year. Despite waste incineration increasing, emissions have fallen:

I. The waste sector will reduce its emissions of greenhouse gases by 76 per cent during the years 1990-2020, according to the Climate Committee's forecast.
II. Waste incineration in Sweden produced as much energy in 2007 as 1.1 million m^3 of oil, which reduces Co_2 emissions by 2.2 million tons per year, as much as 680,000 petrol-powered cars emit in a year.
III. Despite waste incineration increasing, emissions have fallen. For example, emissions of heavy metals from waste incineration into the air have fallen by almost 99 per cent since 1985. In addition, the total emissions of dioxins from all of the country's waste incineration plants have fallen from around 100 g to less than 1 gram during the same period.

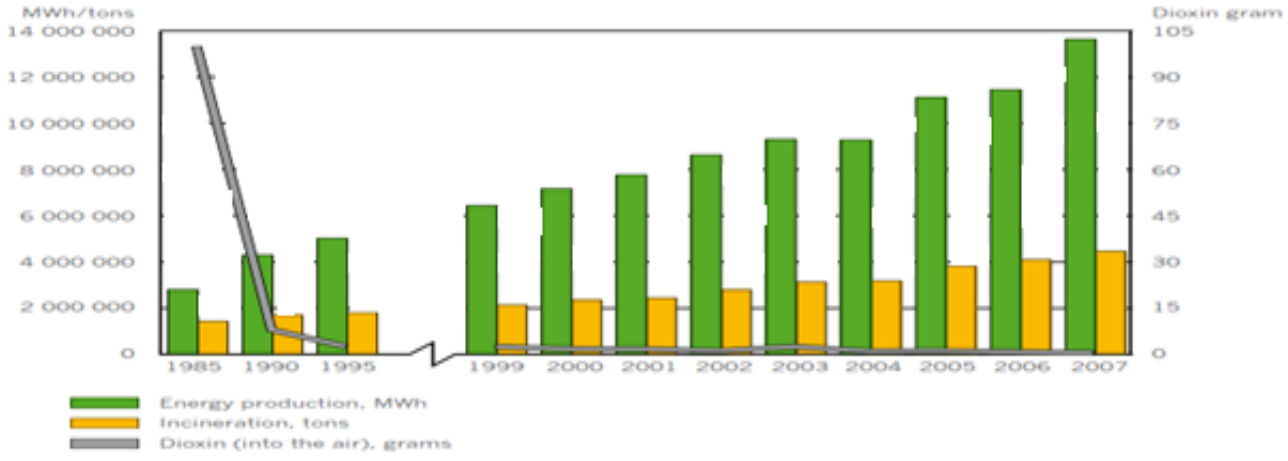

Figure 4.3 Incineration, energy production and dioxin into the air from waste incineration 1985-2006

4.3.2 Laws and control measures that apply to the waste field:

I. The environmental Code, which came into force on 1 January 1999.
II. The EU landfill directive was adopted in 1999
III. The tax on waste for landfills (SEK 250/ton) was introduced in 2000.
IV. The ordinance on landfilling of waste was introduced in 2000
V. A ban on landfilling of sorted combustible waste was introduced in 2002.
VI. The landfill tax was raised to SEK 370/ton in 2003
VII. A ban on landfilling organic waste was introduced in 2005.
VIII. The landfill tax was raised to SEK 435/ton in 2006.
IX. All landfills must have fulfilled the requirements of the 2008 landfill directive in order to be able to continue to receive waste.
X. The framework directive 2008.

At the same time, a number of other rules to regulate waste incineration have been introduced

I. An ordinance on waste incineration was introduced in 2002.
II. An ordinance and regulation about waste incineration came into force in 2005.
III. a tax on household waste for incineration was introduced on 1 July 2006. The tax payable is dependent on whether the incineration plant liable to pay tax produces electricity, and if so, how effectively. For plants without electricity production, the tax is around SEK 500/ton, which then falls with increasing electricity production. if electricity production is effective, the tax is around SEK 100/ton.

4.3.3 Waste as fuel:

Recovering energy from waste exploits a resource that would otherwise be wasted. At the same time, it is important that waste has been source separated. It must not contain hazardous waste, batteries, light bulbs or other electrical waste. Nor should it contain packaging or newspapers. These should be sorted out and left for material recycling. Metal should also be removed, as metal is a raw material with a very high recycling value. Metals can also cause problems in the incineration process with unnecessary wear and unforeseen operational stoppages at the plant as a result.

Plaster should also be removed. Plaster, which is a chemical compound containing calcium and sulphur, provides no energy. The rest is waste from industries and other commercial activities. Waste from industries and other activities often contains sorted fractions with a more homogeneous composition, but the fractions differ significantly from various activities. Household waste sent for incineration varies slightly depending on which municipalities the plant has signed agreements with.

Normally, waste sent for incineration is source-separated combustible household waste. Requirements for fuel properties are set for other waste supplied to the plants. The waste should, for instance, not have too high a moisture content or contain material that is unsuitable for incineration. Random testing and inspections when the waste is received at the plant help to ensure that the requirements are fulfilled.

4.3.4 The waste route through the modern plant:

Let us have an example about the plant. All plants are designed according to local conditions.

1. The waste arriving at the plant must be weighed and quality-checked. The combustible waste is tipped down a bunker. This is often designed to hold several days of waste deliveries in order, for instance, to be able to cope with long weekends. The bunker in one of Sweden's largest plants contains 12,000 m^3 waste.
2. An overhead crane controls the grab bucket and the waste is released into the feed hopper, from where it is fed into the furnace. The overhead crane mixes the waste in the bunker before transferring it to the feed hopper. In order to ensure even, controlled incineration, it is also important that the feed from the feed hopper into the furnace takes place in a well-controlled way.
3. In the furnace, the temperature is normally around 1,000 degrees C, and no fuel other than the waste is required. The waste burns under a stream of air before dropping onto a bed or grate. The hot flue gases rise upwards. There is often also an oil burner in the furnace which is used to start and stop the furnace.
4. All combustible material is consumed. What is left is known as 'slag'. The slag drops down into a water-filled trough and is transported to be sorted and recycled.

5. The actual furnace contains long welded pipes. The total length can be tens of kilometers long. There, the furnace water is circulated and heated to steam by the hot flue gases. The greater the pressure and temperature of the steam, the greater potential for electricity production. At the same time, increased pressure and temperature also lead to a greater risk of corrosion and increased maintenance costs.

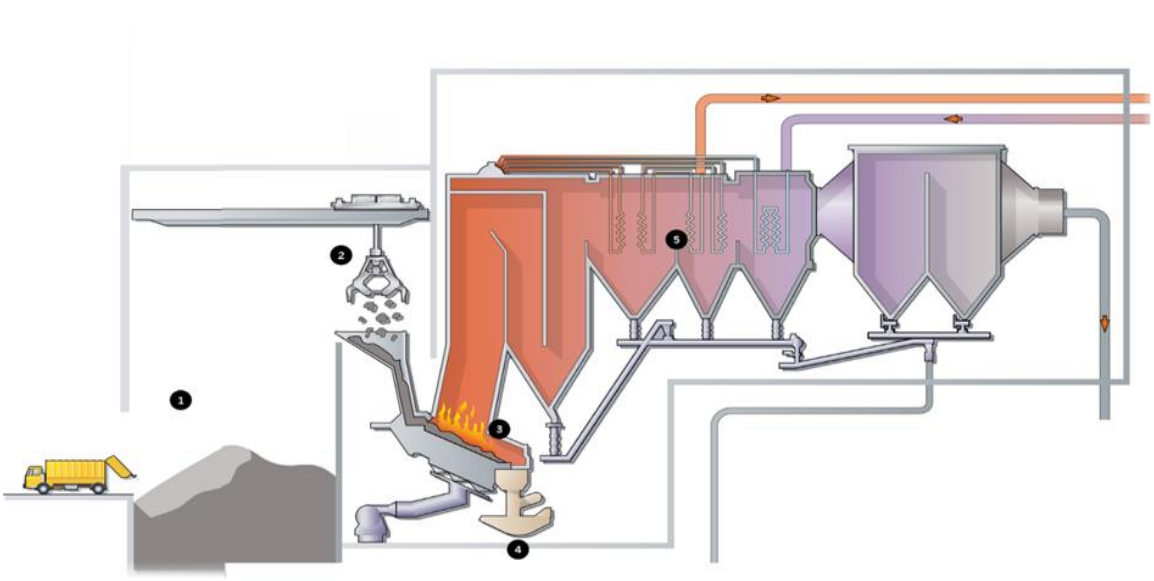

Figure 4.4 First five steps of modern waste plant.

6. Due to the high temperature and steam pressure, it is possible to recover electricity, cooling and heat. The superheated steam is transported to the turbine, which then drives the generator.
7. In the generator, the movement of the turbine is transformed into electrical power, which is delivered to the electricity network.
8. Once the steam has passed through the turbine, it still contains a lot of energy, which is used as district-heating.in a heat exchanger, a condenser, heat is transferred from the steam to the water in the district-heating network. The steam is condensed into water and pumped back to the furnace.
9. The heat produced by Swedish waste to energy plants corresponds to heat demands of 810,000 homes. The hot district-heating water is distributed via well-isolated pipes out to customers. The temperature of the water varies between 70 and 120 degrees, depending on the external temperature. The water is then transferred back to the plant to be reheated.

District-cooling is based on the same principle as district-heating, but instead of providing heat, it provides cooling. Cold water is distributed in a pipe network and cools the air in the ventilation system. The water is then transferred back to the production plant to be cooled again.

10. Electricity from waste to energy plants in Sweden corresponds to the domestic requirements of 250,000 homes.

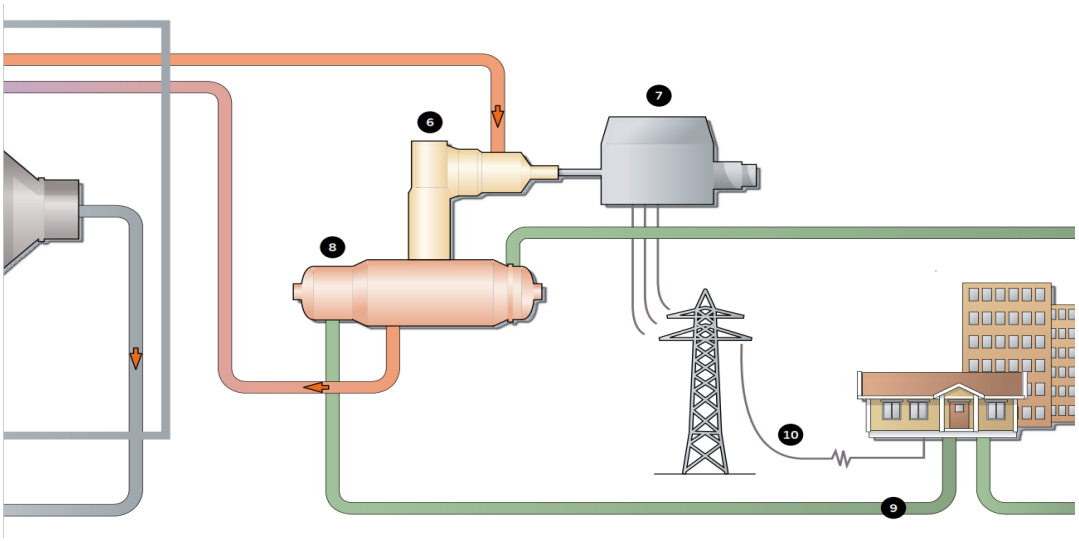

Figure 4.5 Fifth to tenth step of modern waste plant.

11. Once the energy has been extracted from the waste, the flue gases are cleaned. first, they pass through an electrostatic precipitator, where most of the dust is removed. Here, electrodes give the dust particles a negative electric charge. The particles then stick to large metal plates that are positively charged. The dust particles are shaken from the plates, collected at the bottom, and then transported to an ash silo.
12. The next stage of cleaning involves washing the flue gases with water. This is done in towers, known as scrubbers. Nozzles spray a fine mist of water over the flue gases. The water contains various substances, scubas lime, which reacts with the gas and cleans it. In the first scrubber, heavy metals and acidic substances are washed out. The next scrubber removes sculpture dioxide, with the third condensing any moisture remaining in the gas. Heat is extracted from the condensed water using heat pumps.

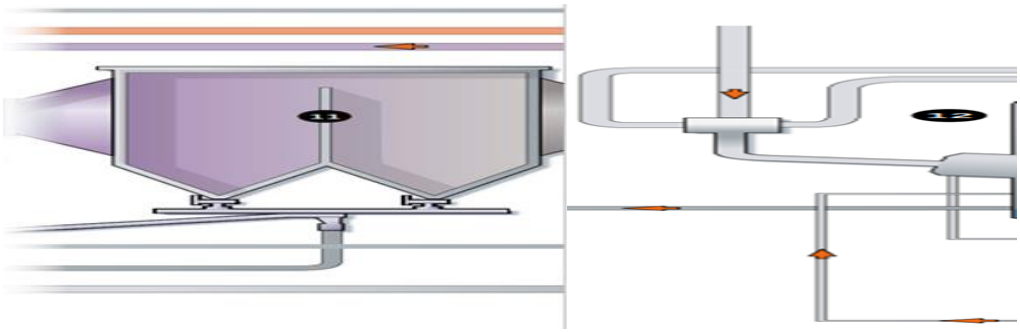

Figure 4.6 Eleventh and twelfth step of modern waste plant.

15. The final stage of the cleaning process is a catalytic converter. This reduces the nitrous oxide and functions in principle in the same way as a catalytic converter in a car. The flue gases pass through a fine porous, ceramic material and, to achieve optimum effect, an ammonia water solution is added. The nitrous oxides, which have an acidifying effect, are then converted into nitrogen. 79 per cent of air consists of nitrogen. another common method is to reduce the nitrous oxides using SNCR or selective non Catalytic reduction
16. The cleaned gas is fed out through the chimney. Harmful substances have been removed, and what is released is, in principle, only carbon dioxide and water.

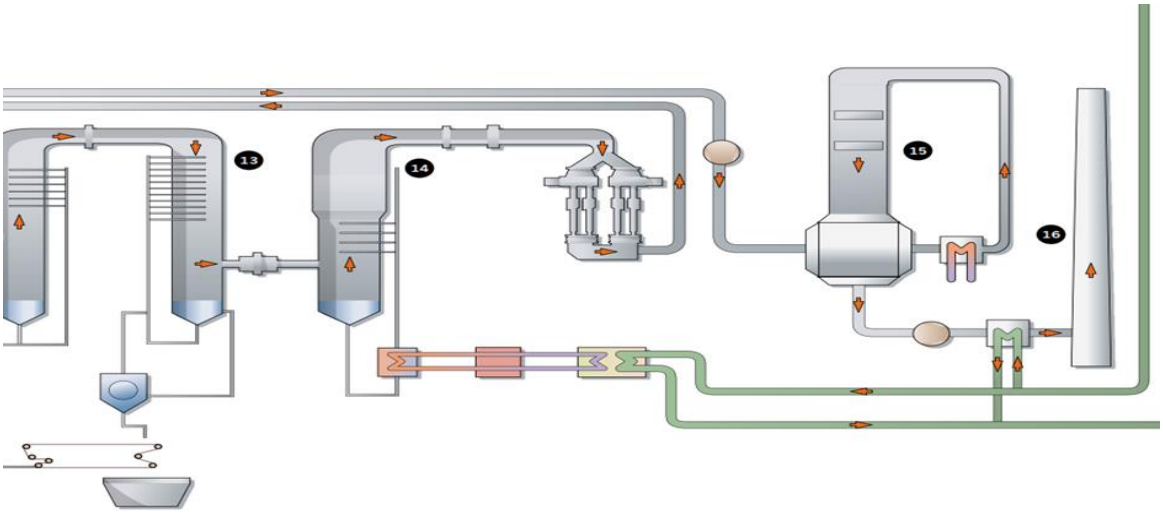

Figure 4.7 Thirteenth to sixteenth step of modern waste plant

17. Much of the pollution that was previously contained in the flue gas has ended up in the water from the scrubbers. This water undergoes a number of cleaning treatments. With the help of various chemicals, heavy metals, among other things, are precipitated and form a sludge that sinks to the bottom of the largest tank, from where it is drained

18. The ph. of the water is adjusted and the water is filtered through a sand filter and a carbon filter before it is released.
19. The sludge from the water purification process is dealt with and finally stored in a safe way.

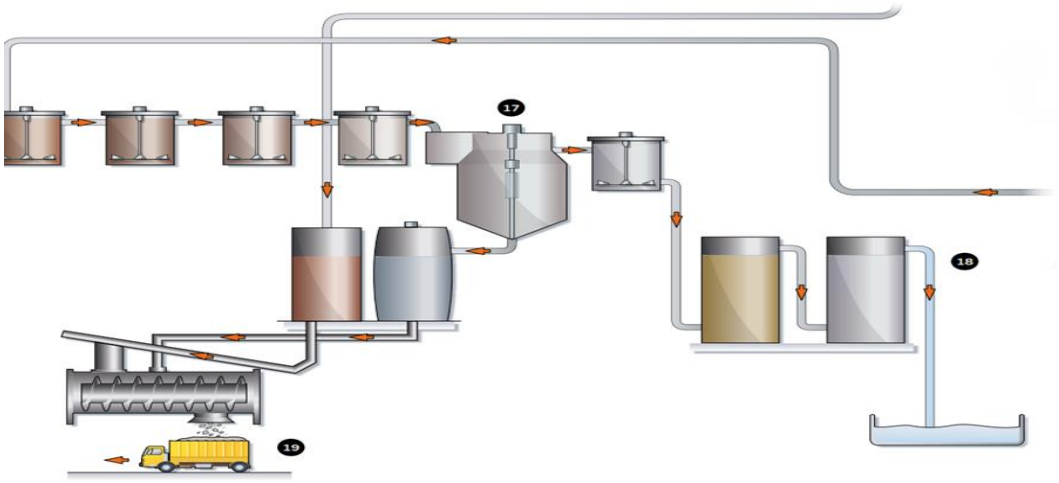

Figure 4.8 seventeen to nineteenth step of modern waste plant

The energy was recovered through waste to energy, an increase of 19 per cent that is equivalent to the domestic electricity demands of almost 250,000 normal-sized homes and heating for 810,000 homes. A small amount of the energy is now also being used to provide district cooling. District-heating is produced by heating water and then pumping it into district-heating pipes to homes, offices, hospitals, industries, schools or other premises. The district-heating pipes are buried in the ground and well insulated. The temperature of the hot water entering the district-heating network normally varies between 70 and 80 degrees C. At low external temperatures, the water temperature may be as high as 100 to 120 degrees C.

The unit contains two heat exchangers, one for hot water for the taps and one for the radiators. The hot water, which is used in the house, and the district-heating water, then circulates in two different systems. The cooled district heating water goes back to the district-heating plant to be reheated. Water is heated to steam at a high temperature and under high pressure, which makes it possible to produce electricity and heat simultaneously, known as combined. Heat and power production (Chp). The steam is fed into steam turbine, which drives an electricity generator. District-cooling is based on the same principle as district-heating, but instead of providing heat,

it provides cooling. Cold water is distributed in a pipe network and cools the air in the ventilation system. The water is then transferred back to the production plant to be cooled again. The temperature of the water being sent out to the properties is around six degrees and the return water is around 16 degrees. District-cooling is mainly used in larger properties such as shopping centres, industries, schools, hospitals and workplaces with heat-generating computers and technical equipment.

4.3.4 Waste to energy recovered:

Table 4.2 Energy recovery from the plant.

Year	2009	2010	2011	2012	2013
Household waste	2,173,000	2,123,680	2,235,720	2,270,650	2,235,930
Other waste	2,322,120	2,704,370	2,671,760	2,771,370	3,043,160
Total (Tonnes)	**4,495,120**	**4,828,050**	**4,907,480**	**5,042,020**	**5,279,090**
Heating	11,502,820	11,752,870	12,798,018	13,031,240	13,762,940
Electricity	1,637,360	1,696,400	1,872,204	1,703,350	1,786,910
Total (MWh)	**13,140,180**	**13,449,270**	**14,670,222**	**14,734,590**	**14,734,590**

4.3.5 Cost of Modern Plant:

Cost required to set up a modern Waste to energy plant is Approx. 100 core and maintenance and operation cost required approx. 10 core per annum. (Rodríguez 2011)

4.4 LANDFILL:

In 2013, 33,300 tons of household waste were sent to landfill. This is an increase of 700 tones, 2.1 percent, compared to 2012. Per capita this is 3.5 kg. 0.7 percent of household waste was sent to landfill in 2013. In 2013, a total of 1,391,900 tons of waste was sent to Swedish municipal landfill sites, a reduction of 163,400 compared to the previous year. However, at Individual plants the total amounts of waste going to landfill can vary significantly from year to year,

depending on a varying need to send contaminated excavated material to landfill. Most waste treatment plants also sort waste materials for transport to reuse and recycling and for energy recovery. Sometimes landfill sites also serve as temporary storage for waste fuel and waste that falls under producer responsibility, such as paper and glass. Plants often also treat biodegradable. In 2013, approximately 245 GWh of landfill gas was collected in total at 58 waste treatment plants, of which 194 GWh was used for energy. Energy recovery consisted of 12 GWh in the form of electricity and the rest in the form of heating. In all, 51 GWh of landfill gas was flared. Flaring does not produce energy but reduces methane emissions. Gas is recovered from 43 active landfill sites.

4.5 RESULT OF SWEDEN MODREN WASTE PLANT:

Average total waste generated form (2009-2013) = 4910352 tones

Average energy generated from (2009-2013) = 14145770.4 MWh.

Average energy produced by 4910352 tones = 14145770.4 MWh.

Average energy produced by 1 tone = 2.88 MWh.

CHAPTER-5

APPLICABLITY OF SWEDEN SOLID WASTE SYSTEN IN SHIMLA

Prevention, reuse, recycling of waste is due to cooperation, engagement and efforts of public and govt. of any country. But it has minor relation with civil engineering (construction management). So if we suppose to implement Waste to Energy modern plant in Shimla. Then we can access the positive impact of this system on Shimla.

5.1 FINANCIAL ASPECT:

Initial cost required to set the Waste energy plant (approx.) = Rs.100,00,00,000
Maintenance and operation cost required for plant = Rs. 10,00,00,000
Average energy produced by 1 tone = 2.88 MWh.

Table 5.1 Energy production from waste/capita/day

Year	Non-biodegradable to the land fill in TPA	Total energy produced every year (MWh)	Total Population	Total energy produced by a person per year
2016	45990	132451.2	358106	0.369866
2017	47543.08	136924.1	369196	0.370871
2018	49134.48	141507.3	380630	0.371771
2019	50725.88	146090.5	392418	0.372283
2020	52118.35	150100.8	404571	0.371012
2021	53655	154526.4	417116	0.370464
2022	55500.08	159840.2	430018	0.371706

2023	57290.4	164996.4	443336	0.37217
2024	59080.73	170152.5	457066	0.372271
2025	60871.05	175308.6	471221	0.372031
2026	62250.75	179282.2	481145	0.372616
2027	64053.85	184475.1	496046	0.371891
2028	66043.1	190204.1	511408	0.371922
2029	68032.35	195933.2	527246	0.371616
2030	70220.53	202235.1	543575	0.372046
2031	71175	204984	553300	0.370475
2032	73602.25	211974.5	570435	0.371601
2033	75989.35	218849.3	588101	0.372129
2034	78376.45	225724.2	606315	0.372289
2035	80763.55	232599	625092	0.372104
2036	81760	235468.8	635500	0.370525
	1324176	**3813627**		

Effective tariff in Shimla= 2.9 Rs/KWh or 2900 Rs/MWh.(HPSEB Tariff Schedule,2016)

Average energy produce in every year= 181601.28

Annual income for the plant= Rs. 526643712

Let us consider an interest of 5 %

5.1.1 Present value of plant:

Present value of annual income= Rs. 6752179454

Present cost of construction of plant = Rs.1000000000

Present value of operation and maintenance cost= Rs.1282115271

Total expenditure on the plant= Rs. 2282115271

Total benefit from the plant= Rs. 4470064183

5.1.2 Total Energy Demand in Shimla city:

Per-capita Energy Consumption (MWh/Person/Year) in Shimla in 2016 = 2.82 MWh/person/year.

Per capita gross energy consumption in the city is continuously growing with a simple average growth rate of 4.5% per year. Now we will calculate energy consumption for every year till 2036.

Table 5.2 Total additional energy required per year.

Year	Total Population	Energy consumption per person at average growth rate of 4.5% per year	Total consumption of energy per year (MWh)	Total energy production per year (MWh)	Total additional energy required per year(MWh)
2016	358106	2.8215	1010396	132451.2	877944.9
2017	369196	2.948468	1088562	136924.1	951638.3
2018	380630	3.081149	1172778	141507.3	1031270
2019	392418	3.2198	1263508	146090.5	1117417
2020	404571	3.364691	1361256	150100.8	1211156
2021	417116	3.516102	1466623	154526.4	1312096
2022	430018	3.674327	1580027	159840.2	1420187
2023	443336	3.839672	1702265	164996.4	1537268
2024	457066	4.012457	1833958	170152.5	1663805
2025	471221	4.193017	1975838	175308.6	1800529
2026	481145	4.381703	2108235	179282.2	1928952

2027	496046	4.57888	2271335	184475.1	2086860
2028	511408	4.784929	2447051	190204.1	2256847
2029	527246	5.000251	2636362	195933.2	2440429
2030	543575	5.225263	2840322	202235.1	2638087
2031	553300	5.460399	3021239	204984	2816255
2032	570435	5.706117	3254969	211974.5	3042995
2033	588101	5.962893	3506783	218849.3	3287934
2034	606315	6.231223	3778084	225724.2	3552360
2035	625092	6.511628	4070366	232599	3837767
2036	635500	6.804651	4324356	235468.8	4088887
Total			**48714321**	**3813627**	**44900685**

The total energy requirement for next 21 years is reduced by 3813627 MWh after the installation of a prototype of the Swedish plant which in turn saves us Rs 11059518300.

5.1.3 Total energy production per capita per year:

By using the smart solution for the solid waste. We will change the word that before using the modern waste to energy plant we use word that one person produce some amount of waste but after the installation of plant we will use word that on person will produce some amount of energy.

Table 5.3 Total waste and energy produced per capita per year

Year	Non-biodegradable to the land fill in TPA	Total Population	Total waste produced per capita per year(tonnes)	Total waste produced per capita per year(Kg)	Total energy produced by a person per year

2016	45990	358106	0.128426	128.4257	0.369866
2017	47543.08	369196	0.128775	128.7746	0.370871
2018	49134.48	380630	0.129087	129.0873	0.371771
2019	50725.88	392418	0.129265	129.2649	0.372283
2020	52118.35	404571	0.128824	128.8237	0.371012
2021	53655	417116	0.128633	128.6333	0.370464
2022	55500.08	430018	0.129065	129.0646	0.371706
2023	57290.4	443336	0.129226	129.2257	0.37217
2024	59080.73	457066	0.129261	129.2608	0.372271
2025	60871.05	471221	0.129177	129.1773	0.372031
2026	62250.75	481145	0.12938	129.3804	0.372616
2027	64053.85	496046	0.129129	129.1289	0.371891
2028	66043.1	511408	0.12914	129.1397	0.371922
2029	68032.35	527246	0.129033	129.0334	0.371616
2030	70220.53	543575	0.129183	129.1828	0.372046
2031	71175	553300	0.128637	128.6373	0.370475
2032	73602.25	570435	0.129028	129.0283	0.371601
2033	75989.35	588101	0.129211	129.2114	0.372129
2034	78376.45	606315	0.129267	129.2669	0.372289
2035	80763.55	625092	0.129203	129.2027	0.372104
2036	81760	635500	0.128655	128.6546	0.370525
Total				**2709.06**	**7.767**

Thus the total average waste produced per capita per year=129.028 kg

And total energy produced by per capita per year= 0.3698 MWh

Thus after the installation of modern waste to energy plant we will not say that one person will produce 129.028 kg of waste but he will produce 0.3698 MWh energy.

CHAPTER - 6

TRAFFIC SYSTEM OF SHIMLA CITY

6.1 EXISTING ROAD NETWORK CHARACTERISTICS OF SHIMLA CITY:

The road network needs to be appreciated for its characteristic assess to existing capacity level of the roads, kind of services offered, along with identification of the constraints, if any, and assess the potential for the improvement/ up gradation of the road network to cater to the existing and projected demands of traffic. The inventory data for road network was analyzed in terms of parameters like type of road, RoW, carriageway, road classification, type of pavement, kind of on-street parking, footpath, street light facilities, road markings, road signage etc. Shimla Urban Agglomeration Area (which covers the area within municipal limit) about 25.20% is under Traffic & Transportation, however the Shimla Planning area (the study area) in a whole has allocated with 3.75% of land under Traffic & Transportation (Source: Draft Master Plan 2021) which is less than required for a large hill town (6-8%, as per UDPFI guidelines).The roads in Shimla have the following broad categories:

6.1.1 Main arterial road network:

Cart Road or Circular Road or Motor Round Road starting from Railway Tunnel No. 103 to Dhalli Tunnel and traversing round the Shimla Hill which is a part of NH 22. This is a main arterial road. Initially this road was designed for the carts, hence named as Cart Road. Over the time, development has led the same road to be used by Motor vehicles naming it has a Motor Round Road. The average road width is about 8 m. The length of Cart road is 18 km. delimiting the Core Area. Pedestrian's footpath are built at critical locations on Cart Road on the valley side in form of cantilever structures that hold the footpaths with hand railings. Traffic timing for heavy motor and goods vehicles on Cart Road through Shimla is restricted from 7.00 AM to 9.00 PM. Traffic signals are installed to look after safety at Victory tunnel junction, Sanjauli Chowk and Dhalli Tunnel.The Cart road provides intersection to minor roads on both uphill and downhill sides at about 66 locations. On-street parking of vehicle is witnessed on all section carefully.

6.1.2 Municipal roads:

Roads connecting to Cart Road are looked after by Shimla Municipal Corporation, thus known as municipal roads.The total length of roads for vehicle movement under the Municipal Corporation as per data available with the SMC is 74.6 kms..

6.1.3 Mall road:

The central market place in the core area and houses a number of heritage sites and buildings lies on Mall Road. The major tourist attraction of Shimla is the Mall.The road from Boileauganj to Scandal point and from Scandal point to Secretariat and from Scandal Point to Sanjauli Chowk forms the Mall road. The road along the Mall is basically for pedestrian movement and entry is restricted for vehicles except for vehicles with permits and emergency vehicles.

6.1.4 Municipal pathways or staircases:

Municipal paths along with stairs for pedestrian movement are in the form of backlog pedestrian. These stairs are been used for manual transportation of goods/payloads by porters. The total length of walk paths under SMC is 73 kms..

6.1.5 Lift:

The Mall road and the Ridge are used for only pedestrian movement. The accessibility to these areas is through pathways/staircases and the lift. The mechanized transport system available for vertical mobility between Cart road and the Mall road is through the Lift.

Total road length of Shimla city is 193.65 kms. Footpath are available at 30.09 kms road and remaining 163.56 kms road has no footpath. Only 16 % of the road network has footpath while 84% of the road network do not have footpaths. Street lighting are available at 30.09 kms road and remaining 163.56 kms road has no Street lighting. 74.5% of motor able roads under Shimla Municipal Corporation (SMC) or 36% of total roads under SMC have Street lighting facility.

Figure 6.1 Road network in Shimla Area

6.1.6 Registered vehicles Growth:

In Shimla Planning Area the number of registered vehicles has increased from 16,450 vehicles in 1995 to 48,000 vehicles in 2011. The Current population of the four wheelers constitute 50% of total registered vehicles, while two wheelers constitute 20% of total registered vehicles, together with the share of private vehicles is 70%. Van or maxi cab used for rage purpose for tourist taxi constitute 13% of total registered vehicle. Only 3% of total registered vehicle are buses.

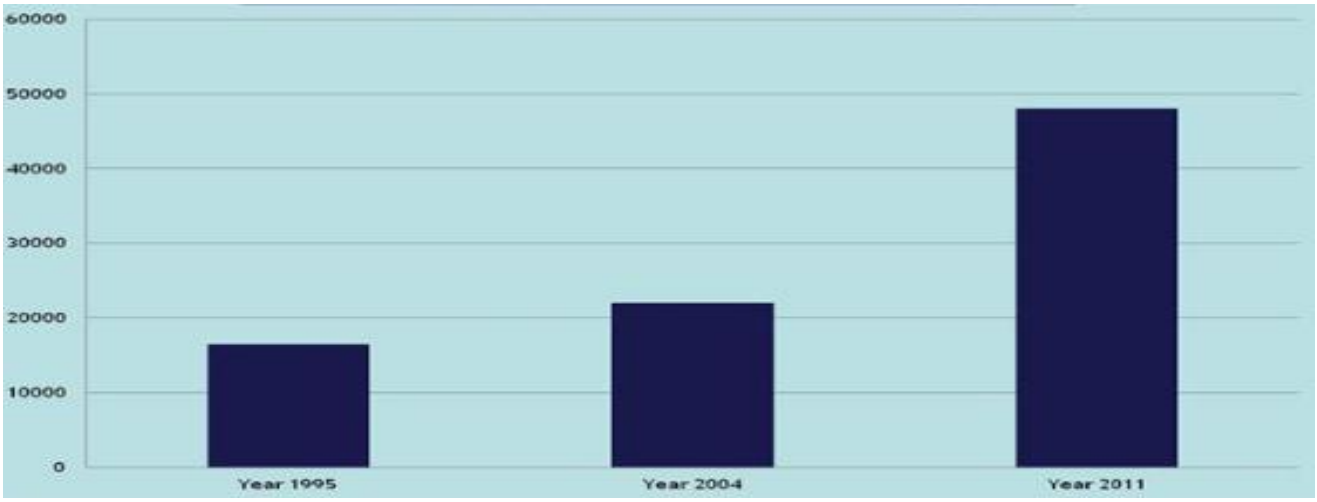

Figure 6.3 Growth of registered vehicles

CHAPTER – 7

DEGREE OF CONFLICT BETWEEN PEDESTRIANS AND VEHICLES

The moment of pedestrians on carriage way of road cause traffic hindrance and increase the journey time, wastage of fuel and impact on traffic flow. Inadequate/unspecified pedestrians crossing cause traffic hazards leads to many accident. As per traffic police Shimla information about 149 minor/major accident occurred during year 2016.

The degree of conflict between pedestrians and vehicles is determined by PV^2 where V is the two way total hourly flow of vehicles and P is the two-way total hourly flow of pedestrians crossing the road within 50 m on either side of the site during peak hours. If the value of PV^2 exceeds 10^8 (or 1 =$PV^2/10^8$) for an undivided road or 2 x 10^8(or 2 = $PV^2/10^8$) for a divided road, then there is requirement of pedestrian crossing facility.

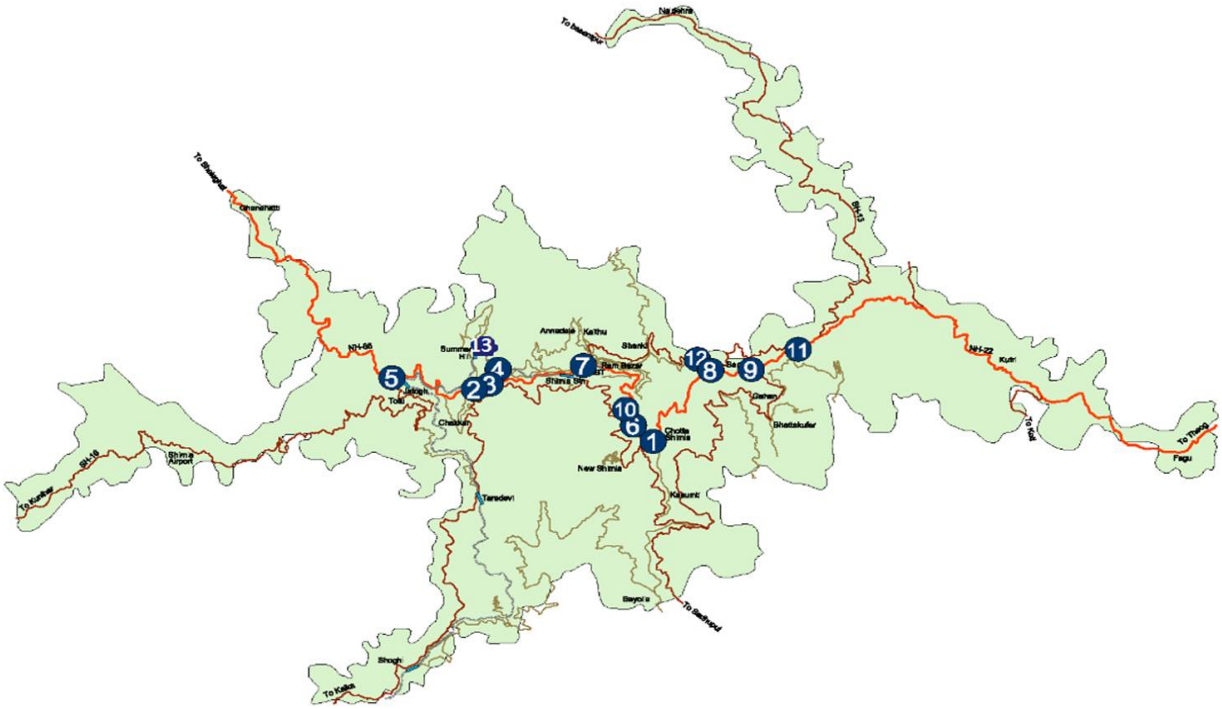

Figure 7.1 Map showing survey locations

7.1 PEDESTRIAN VOLUME COUNT:

Pedestrian volume surveys were conducted at all major intersections and mid-block locations to assess the pedestrian volume and flow across and along the intersections/mid-block for designing of pedestrian facilities at 13 location.

Table 7.1 Pedestrian volume count:

S.NO	Name of Location	Peak Hour(am)	Along	Across	Total
1	Chota Shimla	09:45-10:45	627	178	805
2	Boileaugunj	08:30 – 09:30	534	89	623
3	Tutikandi bypass chowk	09:00 – 10:00	221	54	275
4	Bilaspur chowk	09:30 – 10:30	351	169	520
5	Totu chowk	09:15 – 10:15	1160	160	1320
6	Khallini chowk	10:00 – 11:00	2099	70	2169
7	Victory tunnel chowk	09:00 – 10:00	2456	101	2557
8	Sanjauli chowk	09:00 – 10:00	9570	1602	11172
9	Dhalli tunnel by pass chowk	08:30 – 09:30	1666	410	2076
10	Kusumpti chowk	09:45 – 10:45	835	409	1244
11	Dhalli bus stand chowk	09:00 – 10:00	1039	72	1111
12	IGMC chowk	09:15 – 10:15	556	12	568
13	University chowk	09:15 – 10:15	1185	376	1561

7.2 TRAFFIC VOLUME:

The traffic counts both in terms of numbers of vehicles and passenger car units (PCUs) have been computed at various 13 locations and shown in Table 7.3. Volume is converted into flow using PCU factors as given in IRC SP-41. IRC has given fixed PCU factors for different vehicles for analysis of traffic at intersections as given in table 7.2. These factors are used to convert vehicles into equivalent PCU.

Table 7.2 List of PCU factors given in ICR SP-41

S.NO.	Types of Vehicles	IRC SP- PCU Values
1	Big car	1
2	Small car	1
3	Three wheeler	1
4	Two wheeler	0.5
5	Bicycle	0.5
6	Cycle rikshaw	1.5
7	Lcv Goods	1.5
8	Buses	3
9	Mini buses	3
10	Two axle truck	3
11	Multi axle truck	4.5
12	Tractor with trailer	4.5

Table 7.3 Traffic volume at 13 different intersection:

S. No.	Name of Location	Peak Hour(am)	(PCU's)
1	Chota Shimla	09:45-10:45	1561
2	Boileaugunj	08:30 – 09:30	283
3	Tutikandi bypass chowk	09:00 – 10:00	1373
4	Bilaspur chowk	09:30 – 10:30	1188
5	Totu chowk	09:15 – 10:15	1170
6	Khallini chowk	10:00 – 11:00	865
7	Victory tunnel chowk	09:00 – 10:00	3577
8	Sanjauli chowk	09:00 – 10:00	1517
9	Dhalli tunnel by pass chowk	08:30 – 09:30	932
10	Kusumpti chowk	09:45 – 10:45	1779
11	Dhalli bus stand chowk	09:00 – 10:00	1045
12	IGMC chowk	09:15 – 10:15	1023
13	University chowk	09:15 – 10:15	671

As both the pedestrian volume and traffic volume has been calculated we have to calculate the degree of conflict between pedestrians and vehicles by PV^2 as shown in Table 7.4 where V is the two way total hourly flow of vehicles and P is the two-way total hourly flow of pedestrians crossing the road.

Table 7.4 Degree of conflict between pedestrians and vehicles:

S. No.	Name of Location	P	V	V^2	PV^2	$PV^2/10^8$
1	Chota Shimla	178	1561	2436721	433736338	4.33738
2	Boileaugunj	89	283	80089	7127921	0.07121
3	Tutikandi bypass chowk	54	1373	1885129	101796966	1.01796
4	Bilaspur chowk	169	1188	1411344	238517136	2.38516
5	Totu chowk	160	1170	1368900	219024000	2.19024
6	Khallini chowk	70	865	748225	52375750	0.52375
7	Victory tunnel chowk	101	3577	12794929	1292287829	12.9228
8	Sanjauli chowk	1602	1517	2301289	3686664978	36.8666
9	Dhalli tunnel by pass chowk	410	932	868624	356135840	3.56135
10	Kusumpti chowk	409	1779	3164841	1294419969	12.9441
11	Dhalli bus stand chowk	72	1045	1092025	78625800	0.78625
12	IGMC chowk	12	1023	1046529	12558348	0.12558
13	University chowk	376	671	450241	169290616	1.69296

Thus it is clear from table 7.4 that 9 location of Shimla required improvement in pedestrian crossing facility. Requirement improvement in pedestrian crossing facility can be either though overpasses and underpasses pedestrian. Pedestrian Overpasses and Underpasses completely separate pedestrians from vehicular traffic and provide safe pedestrian accommodation.

7.3 CONSTRUCTION COST FOR PEDESTRAIN BRIDGE:

Key Assumptions, Costs are assumed to include engineering, design, mobilization, and furnish and installation costs.pedestrian are eight feet in width and have a thickness of four inches and having length of two lane. The cost for specific types of bridges can vary substantially, based on the specific situation, materials, and other factors, as demonstrated in the table 7.5 below for wooden and pre-fab steel bridges(For two lane).

Table 7.4 Estimated cost for pedestrian bridge:

Infrastructure	**Description**	**Minimum**	**Maximum**	**Cost Unit**	**Number of Sources (Observations)**
Overpass /Underpass	Wooden Bridge	$91,010	$124,670	Each	1 (8)
Overpass/ Underpass	Pre-Fab Steel Bridge	$41,850	$206,290	Each	5 (5)

The cost of one Overpass/Underpass Wooden Bridge is $124,670 approx. If We have to construct 9 Overpass/Underpass Wooden Bridge in Shimla the amount required is $124670 (Rupees 8150924.6) The cost of one Overpass/Underpass Pre-Fab Steel Bridge is $206,290 .If We have to construct 9 Overpass/Underpass Pre-Fab Steel in Shimla the amount required is $1856610(Rupees 121385161.8)

CHAPTER -8

CONCLUSION

The idea of the smart cities revolves around the compact areas, creating a reliable plan. Main scope of this study is to investigate the different feature of smart city in hilly region and to find out the different step taken to develop Shimla as smart city and also to suggest different technique or strategies for smart city in Shimla.. SMART CITY means installing the convenient and advanced technology for the uplift society. It should emphasis on the production of more of energy rather than its consumption. If by installing modern waste plant for Shimla city as per the case study of this project we found that the energy of about 0.3698 MWh per capita per year can be produced. Study also helped that if this modern plant continues the profitable sum of Rs. 4470064183 can be achieved in coming next 21 years.

Before the introduction of smart modern waste plant, the generation of the waste contributes about approximately 129.028 kg waste per capita per year. Adopting the technique benefitted us by providing 0.3698 MWh energy. The similar concept by Sweden, The Environmental Protection Agency is responsible to reduce the amount of waste. It focuses on four waste streams that have a major environmental impact. Textile, food, electronics and removal of waste. Targets was set by the EPE of Sweden is the quantity of waste going to landfill, not including mining waste, must be reduced by at least 50 per cent by 2005 along with Zero waste vision. The similar hilly region geographical factor gave an idea of utilizing the same for Shimla. Therefore it is important to know the quantity and characteristics of solid waste generated, before designing the appropriate solid waste management system in a town. Field investigation studies were carried out, to assess the quantity and characteristics of solid waste generation in Shimla.

Benefits drawn from the modern waste plant to putting the environment waste to production of energy, at the same time minimizing the impact on, and risk to, health and the environment. Reduced landfilling and increased recovery and recycling can largely be achieved by household sorting of waste at source. By incineration, many harmful substances break down and the residual substances are bound in ash, which makes them easier to control, handle and recycle.

The environmental factor can be saved. The landfill occupied placed by be utilized in other better way. The study case with the concept of smart waste disposal not only contributes to drawn benefit from the waste and make our city economically sound.

For smart city the smooth flow of traffic play very important role, hence planning of city/smart city the free flow of traffic plays very important role, being a hilly station and having number of redistricted road. The overpasses and underpasses are essentially required for pedestrian. At least 50% population/tourist move to their destination point. The number of pedestrian crossing is required. It is observed that at least 9 place required overpasses/underpasses to pedestrian so that traffic moment could not hinder.

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