

## Hospital Waste Characterization and Proposal of Management Technique for Onsite Disposal in Ujjain City

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### Abstract:

Hospital waste management is attaining too much concern because of latest environment safety programmes running around globally. Improper management of waste leads to risk of public as well as their surroundings. Waste management is a process that provides proper guidance for handling and treatments of waste. It offers variety of solutions for reducing the waste and protection of environment from waste as well as encourages recycling process. Our research has mentioned the quantities, proportions, categories, handling, treatment and disposal methods in hospitals present in Ujjain city. Our research has mentioned the quantities, proportions, categories, handling, treatment and disposal methods in Ujjain hospitals. The methodology of our study is color coding waste collection system and also proposed some hypothesis based on our research.

**Keywords** - Hospital waste, recycling, improper management, proportions, categories, handling, treatment, Ujjain hospitals

### INTRODUCTION

Each and every kind of waste generated, discarded and not in further use within the hospital premises is known as Hospital waste. The waste generated in hospitals is generally divided into eight categories (Human anatomical waste, animal waste, sharps, microbiological & biotechnical waste, cytotoxic waste, genotoxic waste, chemical and pharmaceutical waste) according to world health organization (WHO), and the most appropriate way of categorizing the waste by sorting them according to the color code (yellow, blue, red, white, black). Waste must be segregated at the point of waste generation according to the schedule II of bio medical handling rules 1998.

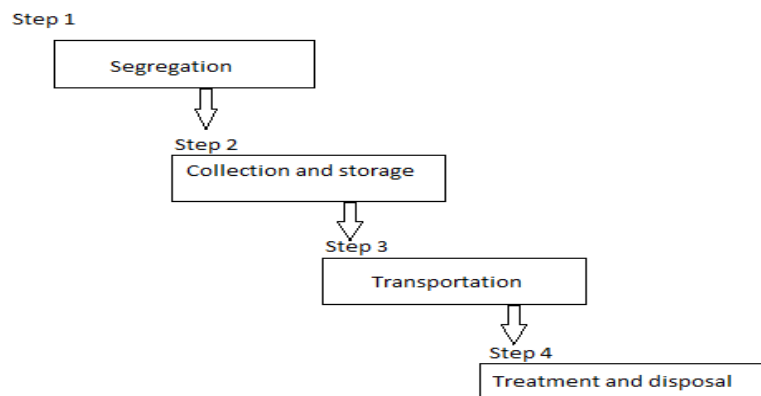
The management of hospital waste is not only the liability of the hospital administration but also of each & every department and healthcare providing personnel within the hospital premises. It is a course of action that should start on at the point of generation where hospital waste must be properly collected and segregated from other waste in specific color-coded systems.

### Description of Area

Ujjain is one of the religious place of Madhya Pradesh, India with the population density of 330 (people/square km). City has approximately total 4 government and 53 main private hospitals. Every day tons of hospital waste is generated by the hospitals of Ujjain and the proper management of this waste is necessary otherwise hospital will become a source of fatalities too.

### Steps for management

There are generally four basic steps for hospital waste management segregation, collection & storage, transport, treatment & disposal of waste.



**Techniques that we have used for waste disposal**

- **Reduction of waste generated:** Reduction of waste at source of generation is the most effective way to minimize the waste quantity. We have total 20,172 kg of waste that is not a small amount. Total 35%- 40% of total waste is reduced via using recovery & recycling, segregation, composting, sterilization and incineration process.
- **Recovery and Recycling:** It is the second step used in waste disposing method because most of the type of materials that were used in hospitals can be further use after proper treatment means they not need to be direct landfill or incinerate. Almost whole organic waste can be recovered in form of useful materials, plastic, glass, rubber and some kind of sharps can be recycled, and hence 15% - 20% waste can be recycled.
- **Sterilization:** It is the most common method used by hospitals. It is a low capital cost treatment. Many type of waste cannot be directly disposed off; it needs to be first sterilized. Sharps, some kind of glass as well as plastic materials and clothes are sterilized and hence 10% - 12% waste is treated.
- **Composting:** It is a safe way of organic waste disposing. Almost 90% - 99% organic waste is safely decomposed and results in form of manure and biogas. We have used vermin composting treatment <sup>[2,3]</sup>
- **Incineration:** It involves combustion of waste at high temperature and converts the waste into residues and gaseous forms. Human anatomical waste, animal waste, microbiological waste, soiled waste needs to be incinerated.
- **Sanitary landfill:** It is the last but important step too. At the last some materials needed to be land filled. Like incinerated ash and some left over materials are land filled.

**METHOD FOR SAMPLE COLLECTION**

First, we have done a survey on hospitals of Ujjain, There are total 4 government and 53 main private hospitals approximately, we not includes small nursing homes and clinics of beds less than 10. Government hospitals generate an average of 0.592 kg/bed/day of the waste and private hospitals generates 0.435 kg/bed/day of waste approx. The various type of biomedical waste generated in the hospital is collected by the all the members of the hospital. Then we done a survey on the type of waste generation in each ward, quantity of waste generated, type as well as time of disposal etc. We have collected the data of quantity of waste generation of hospitals of Ujjain city on the basis of color code system of different shifts for around 21 days alternatively and calculated the total waste collected according to the color coded bags or containers based on shifts. The yellow color is used for highly infectious waste collection, red is for plastic waste and blue bags are for all type of glass waste and for discarded or outdated medicines. We had started from mid day of weekend Thursday till the next 15 day, and the 15<sup>th</sup> day is also Thursday. We collected the waste within four shifts like wise;

- Shift 1 early morning (till 8AM)
- Shift 2 till noon (till 12PM)
- Shift 3 till 4PM
- Shift 4 till midnight(12AM)

**Table – Quantity of waste generated in Ujjain**

Day	Yellow				Red				Blue			
	S <sub>1</sub>	S <sub>2</sub>	S <sub>3</sub>	S <sub>4</sub>	S <sub>1</sub>	S <sub>2</sub>	S <sub>3</sub>	S <sub>4</sub>	S <sub>1</sub>	S <sub>2</sub>	S <sub>3</sub>	S <sub>4</sub>
1	220	124	409	603	78	87	18	5	85	43	8	6
3	150	160	611	603	88	96	10	9	96	70	12	19
5	186	150	510	492	89	75	11	9	98	71	13	28
7	182	162	411	498	142	82	10	12	112	72	50	35
9	230	120	120	762	147	112	16	6	198	110	47	22
11	150	134	412	712	150	82	10	5	90	40	42	12
13	180	122	460	680	114	40	10	7	118	90	60	30
15	214	203	421	582	85	73	11	10	161	72	60	39
17	286	138	401	605	190	80	12	12	110	104	62	58
19	231	125	321	583	85	78	13	11	62	89	71	32
21	262	137	308	515	90	62	14	15	131	80	70	28
<b>TSC</b>	<b>2291</b>	<b>1575</b>	<b>4384</b>	<b>6635</b>	<b>1258</b>	<b>867</b>	<b>135</b>	<b>101</b>	<b>1261</b>	<b>841</b>	<b>495</b>	<b>309</b>

S<sub>1</sub> = Shift 1, S<sub>2</sub> = Shift 2, S<sub>3</sub> = Shift 3, S<sub>4</sub> = Shift 4, TSC = total shift wise collection

**Calculation**

Total yellow bag waste generated = (2291+1575+4384+6635) = 14,885 kg of waste

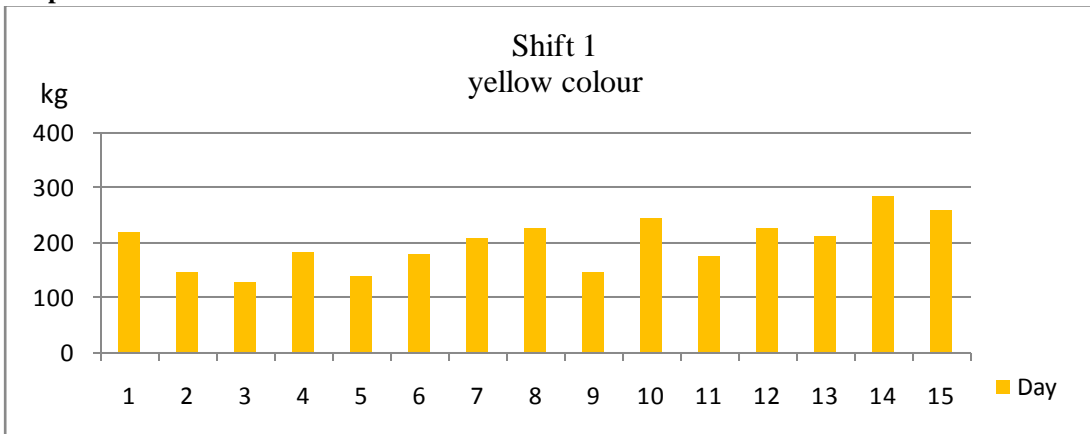
Total red bag waste generated = (1258+867+135+101) = 2,361 kg of waste

Total blue bag waste generated = (1261+841+495+309) = 2,906 kg of waste

Total waste generated = (14,885+ 2.361+ 2,906) = 20,172 kg of waste

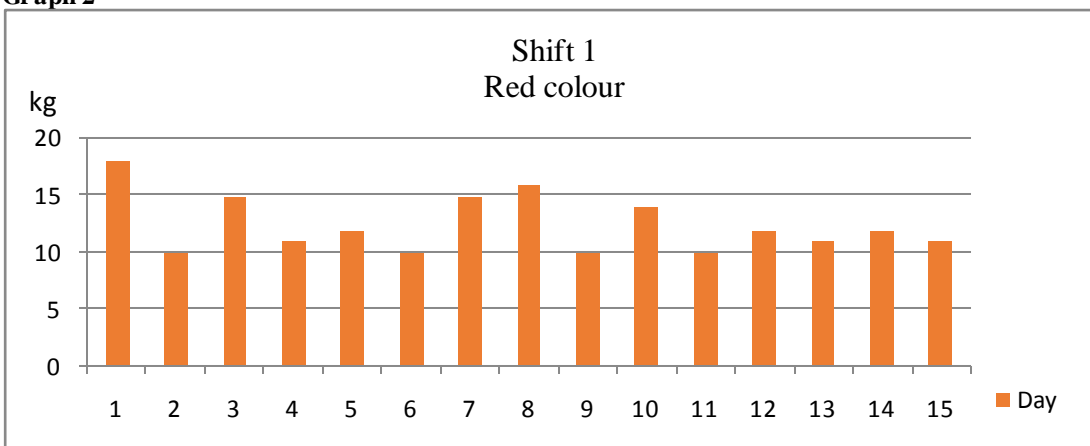
**RESULTS AND DISCUSSIONS**

**Graph 1**



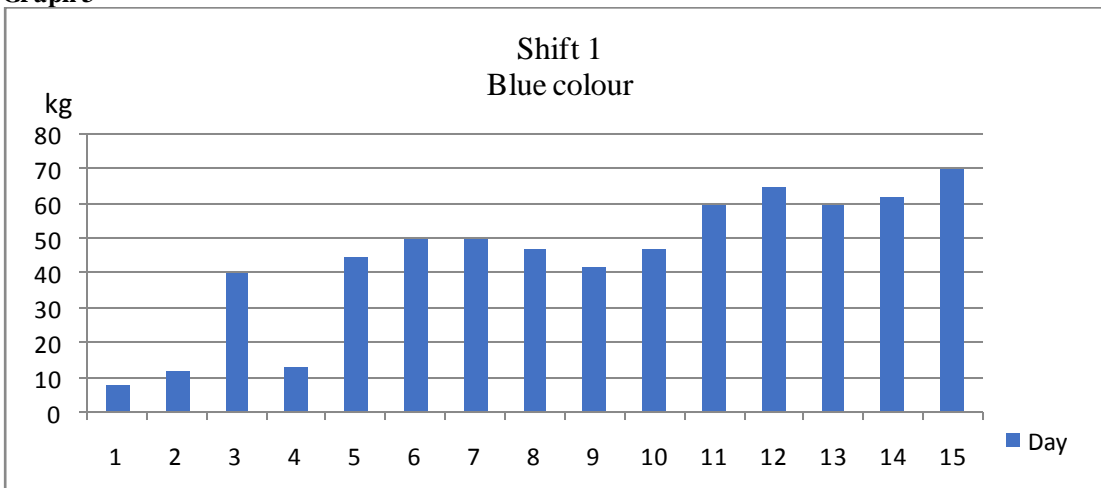
Graph 1 depicts the range of yellow color waste of about 15 days of shift 1 collection. The variation is due to variable deliveries and people admitted in hospitals. As we can see that it is minimum on day 3 as the number of deliveries on that day is less due to Saturday. Its maximum in day 14 as its middle of week and Wednesday considered very holy for babies to born.

**Graph 2**



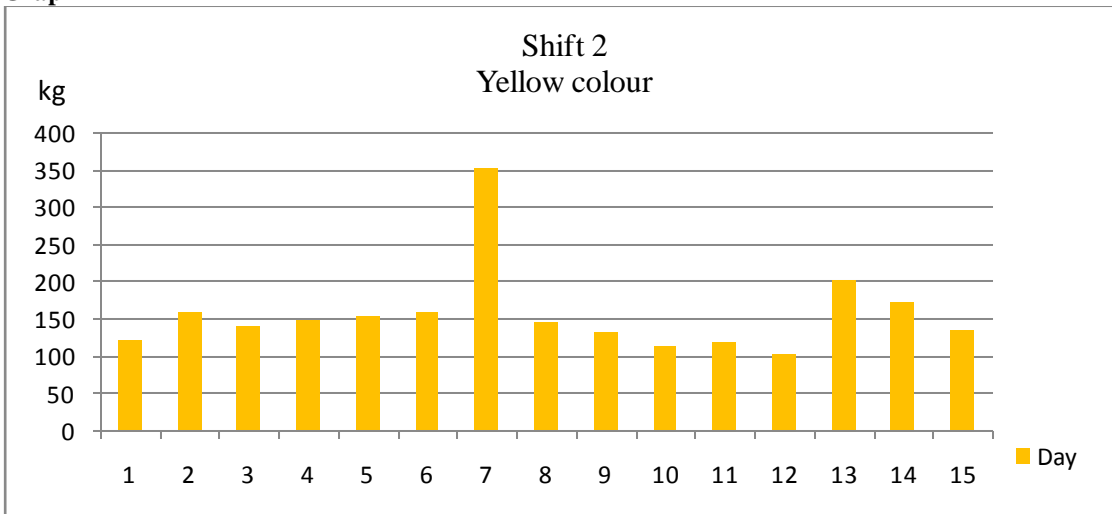
Graph 2 depicts the range of red color waste of about 15 days of shift 1 collection. The range is low as many items are reused using sterilizers. The graph depicts that its maximum on day one as its Sunday and the operation theater is cleaned that day also at that day casualties are more as a accident occurs that day near Ujjain.

**Graph 3**



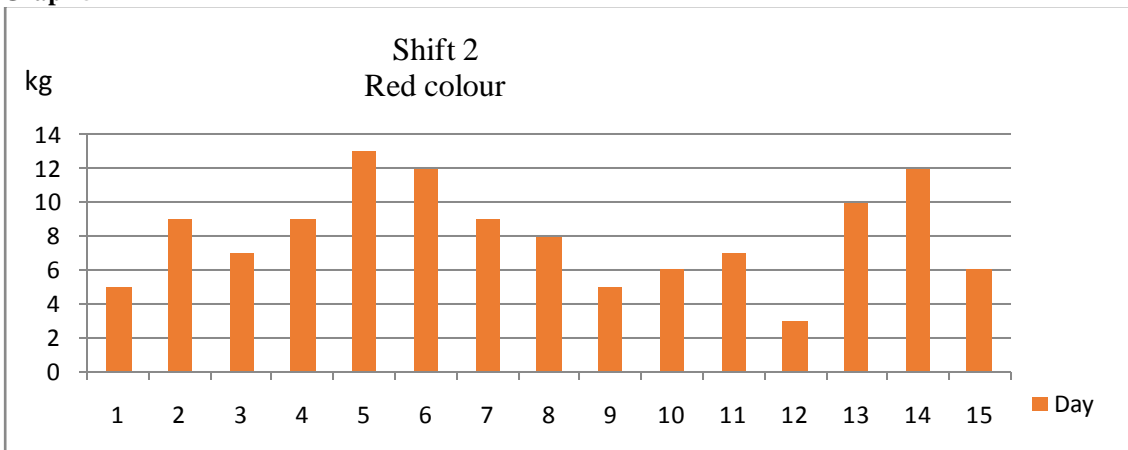
Graph 3 depicts the range of blue color waste of about 15 days of shift 1 collection. Sharps can be reused using autoclave and so are been used but they have their own limit so as the graph depicts its increasing with days as the number of operations are more the sharp waste increases also it increase with number of casualties.

**Graph 4**



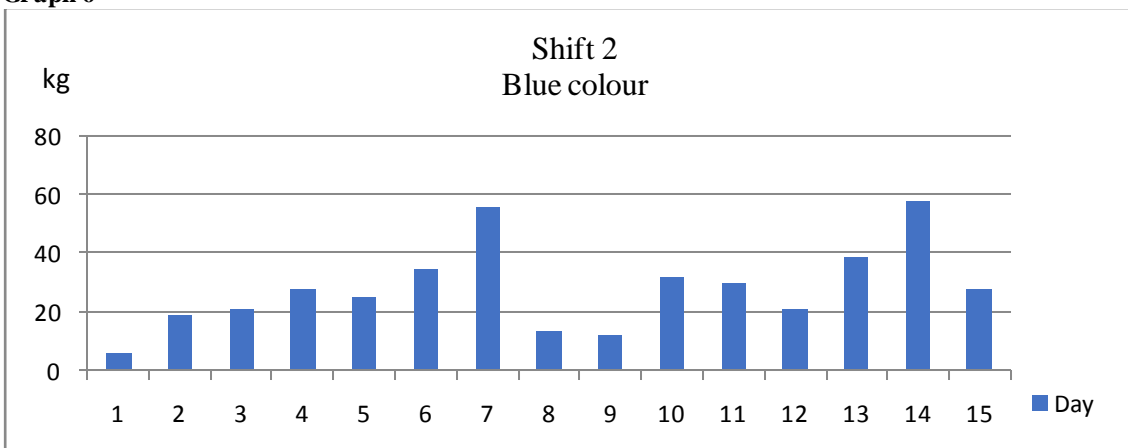
Graph 4 depicts the range of yellow color waste of about 15 days of shift 2 collection. The 7<sup>th</sup> day Wednesday has highest collection as deliveries that day from nearby areas are done in the hospital as less doctors are present that day in 2<sup>nd</sup> shift and 12<sup>th</sup> day Monday has the lowest collection amount because all of the anatomical, microbiological and soiled waste is already has disposed of on weekends.

**Graph 5**



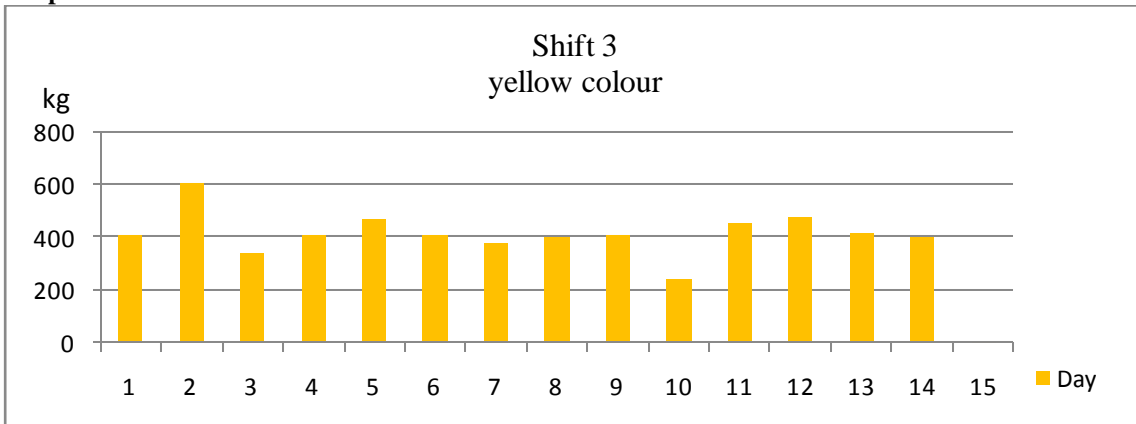
Graph 5 depicts the range of red color waste of about 15 days of shift 2 collection. Day 5<sup>th</sup> has the maximum range and 12<sup>th</sup> day Monday has the minimum collection.

**Graph 6**



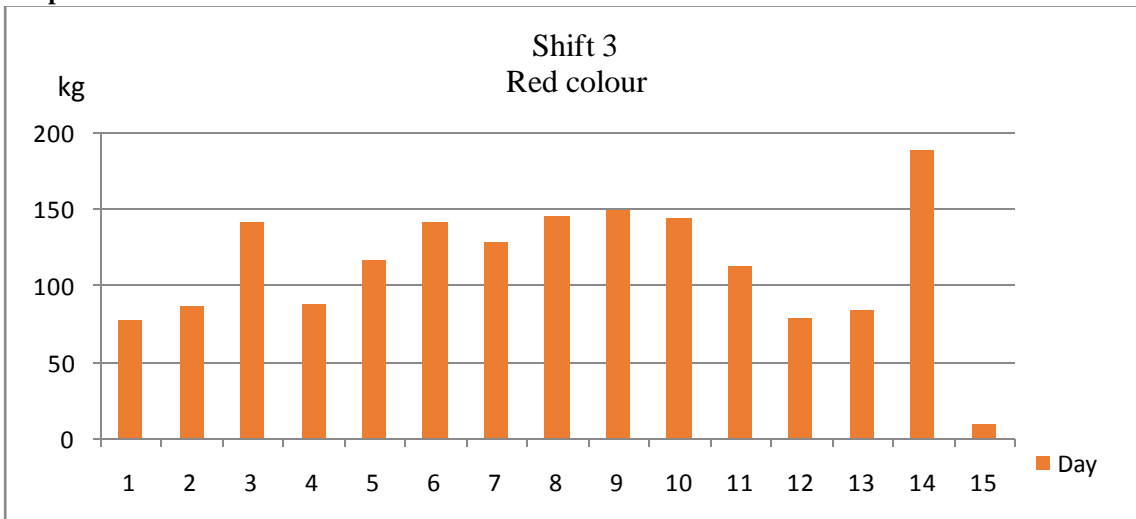
Graph 6 depicts the range of blue color waste of about 15 days of shift 2 collection. 1<sup>st</sup> day has the lowest and 14<sup>th</sup> day has the highest range of for sharps and liquid waste.

**Graph 7**



Graph 7 depicts the range of yellow color waste of about 15 days of shift 3 collection. 2<sup>nd</sup> day has the maximum and 10<sup>th</sup> day has the minimum amount of waste collected.

**Graph 8**



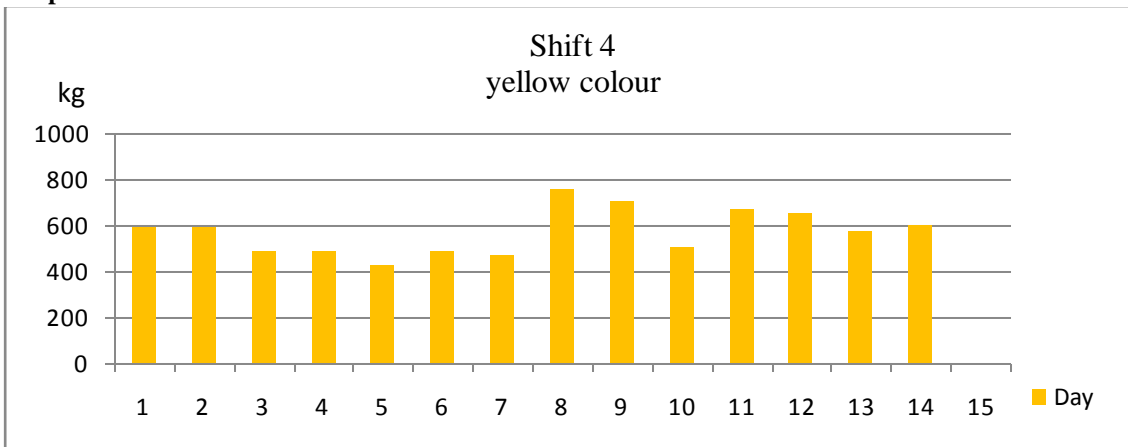
Graph 8 depicts the range of red color waste of about 15 days of shift 3 collection. 14<sup>th</sup> day has the highest and 15<sup>th</sup> day the lowest amount.

**Graph 9**



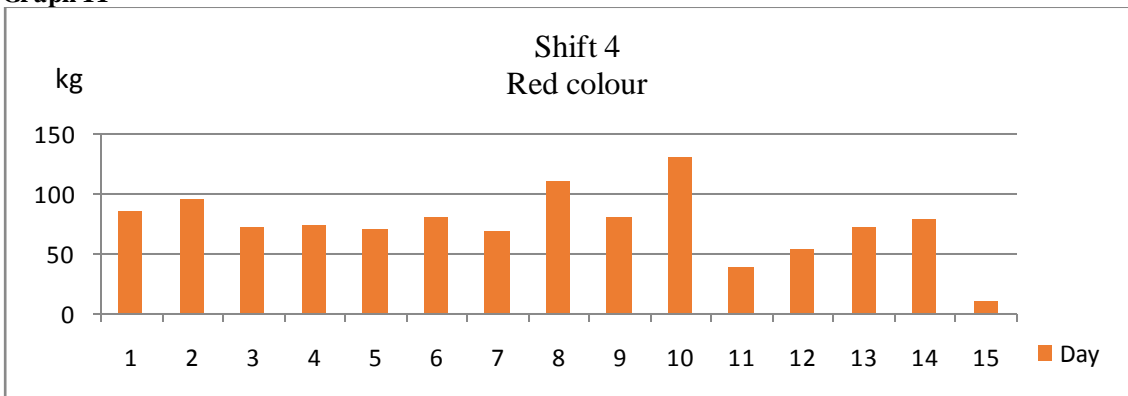
Graph 9 depicts the range of blue color waste of about 15 days of shift 3 collection. 8<sup>th</sup> day has the maximum range and 15<sup>th</sup> day has the lowest.

Graph 10



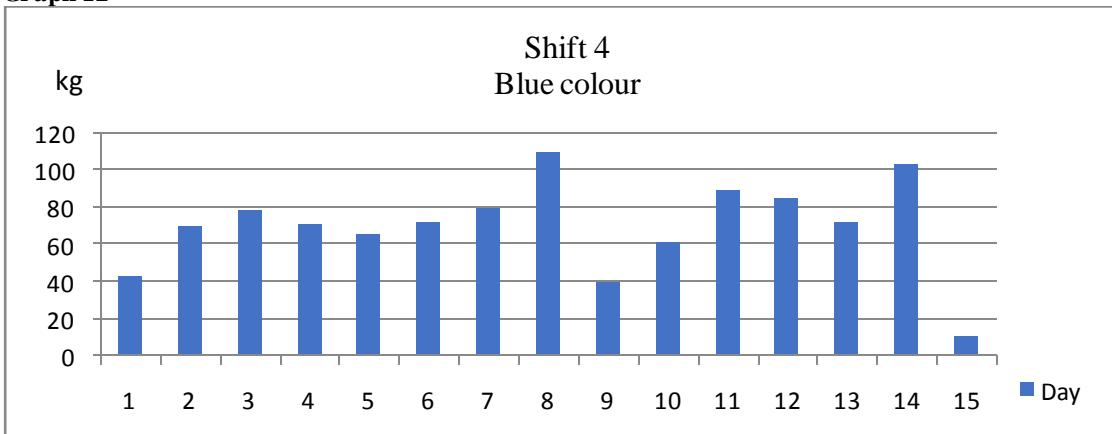
Graph 10 depicts the range of yellow color waste of about 15 days of shift 4 collection. 5<sup>th</sup> day has the lowest and 8<sup>th</sup> day has the highest collection.

Graph 11



Graph 11 depicts the range of red color waste of about 15 days of shift 4 collection. 10<sup>th</sup> day has the maximum amount and 11<sup>th</sup> day has the minimum amount collection.

Graph 12



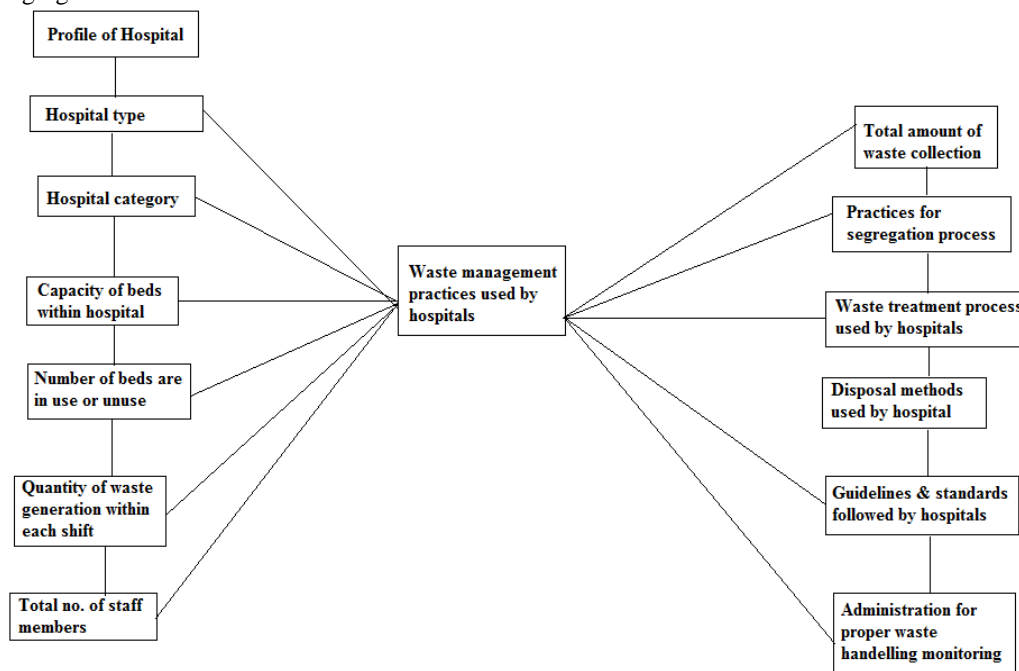
Graph 12 depicts the range of blue color waste of about 15 days of shift 4 collection. 8<sup>th</sup> day Thursday has the highest range and 15<sup>th</sup> day Monday has the lowest range because most of the waste is already been taken away on weekends.

**Result:** Quantity of yellow color coded bags waste is more than the total quantity of red and blue color coded bags together and since the total quantity of waste is approximately 20,172 kg within 21 days, which is quite a huge amount. So hospitals are needed to take more care within their waste management system and should focus more on waste minimization.

### CONCLUSION

Hospital wastes need to be classified according to their source, color, categories, quantity and risk factors related with their handling, treatment, storage and disposal methods. The segregation of waste at point of generation must be the key step and reduction, recycling and reuse should be taken in proper perspectives. Proper management of hospital waste is a concern that has been identified by both government as well as Non government organizations. Inadequate and improper handling and management can cause severe problem to the society and environment hence implementations of protective measures, guidelines, policies etc. factors is made compulsory. Lack of concern in persons working in that area, less motivation, awareness and cost factor are some of the problems faced in the proper hospital waste management. Proper surveys and maintenance of records of waste management in various practices are needed.

We have formulated some hypothesis on the basis of our survey of Ujjain city’s hospitals, which we have described with following figure.



**Fig. for mulation of management practices based on our research**

#### Proposed plans for onsite Treatment

1. **Use of ash left after incineration process:** There will be two kind of ash left over after the incineration done. One is of hazardous nature and other one is of non- hazardous. The hazardous ash can be send for further treatment or can be properly land filled and the non-hazardous ash processed into aggregates and can be used in cement bound materials, bulk filler in construction and in road sub base.
2. **Use of incinerated gases:** Mainly carbon dioxide, sulfur dioxide as well as oxides of nitrogen are the main waste gases generated by the incineration process, so these gases can be used as a heating fuel for the hospital use purposes.
3. **Use of biodegradable waste:** Hospitals can use their organic waste in making manure via vermin composting method also they can use their organic waste to generate the biogas, which can be the source of heat, fuel or electricity for the hospital.
4. **Segregation of non-hazardous waste:** Hospitals can segregate their non hazardous waste into different section too likewise: glass waste, plastic waste, paper waste and kitchen waste etc. and can send them to related industries for recycling.
5. **Waste to Energy:** With the waste to energy concept we can generate electricity and heat that can be used as a source of power for the buildings and industries.

#### REFERENCES

- [1] **Agrawal, D., Dalal, P., & Srivastava, J.** (2017). Biomedical Waste Management in Hospitals – A Review. IRA-International Journal of Technology & Engineering (ISSN 2455-4480), 7(2), 10-16.
- [2] **Agrawal, D., Dalal, P., & Srivastava, J.** Bio-Medical waste management of Ujjain city by on-site treatment of bio-degradable infectious waste by low cost technology. Int. J. Chem. Stud., 2017; 5(4): 01-06
- [3] **Dalal P.** Management of Infectious Bio-medical Waste of Ujjain City International Journal of Advance Research. 2013; 1(2):52-58
- [4] **Dalal P. 2005.** Sustainable development of Holy city Ujjain, India by Solid Waste Management. Journal of Pollution Control Vol 21(2) 2005 Pg. 127-132
- [5] **Dalal P. 2006.** Sustainable development of Ujjain by Solid Waste Management. Our Earth Vol3 (2) pg 5-11.
- [6] **Dalal P. 2011.** Liquid Biomedical waste management strategy. Environmental Conservation Journal Vol 12(1&2). Pg. 87-93
- [7] **Dalal P.** 2012 Municipal solid waste Management by Vermicomposting. International Journal of Science and Nature. Vol 3(4) pg 883-885.
- [8] **Dalal P.** 2017, Proposal of Multi-Hazardous Wastes For On-Site Disambiguation. International Journal of Applied Biology and Pharmaceutical Technology Vol 8(3) 2017 Pp . 29-35
- [9] **The Gazette of India.** (1998) Biomedical Waste (Management and Handling) Rules, Extraordinary Part II Section 3– sub section (ii), pp. 10– 20. India: Ministry of Environment and Forest, Government of India. Notification dated 20 July.
- [10] <http://www.cpcb.nic.in>