

International Journal of Innovative Research in Science, Engineering and Technology

Volume 3, Special Issue 3, March 2014

2014 International Conference on Innovations in Engineering and Technology (ICIET'14) On 21st & 22nd March Organized by

K.L.N. College of Engineering and Technology, Madurai, Tamil Nadu, India

Barriers To Implement Green Supply Chain Management In Indian Hospitals

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ABSTRACT-Hospitals play an important role in protecting the health of a nation. However they also have an unhealthy side - inadvertently contributing to illness and pollution by exposing patients and staff to toxins from building materials, medical waste, hospital supplies and cleaning products that consequently puts pressure on hospital supply chains. The hospital waste management is of immense importance due to its infectious and hazardous nature that can cause many effects on human health and the environment. Government regulations and public awareness regarding hospital waste issues have forced hospital units to adopt some strategies for managing this waste. The new technologies and instruments have been developed to handle hospital wastes. In response to these pressures some hospitals have initiated Green supply chain management practices. Green supply chain management integrates Environmental Management and Supply Chain Management. It has gained popularity in organizations with objectives of reducing waste and preserving the quality of product-life and the natural resources. In this work the potential barriers that prevent the greening effort of the hospital waste sector in India was analyzed and modeled by using Interpretive Structural Modeling (ISM) technique.

KEYWORDS— Hospital Waste Management (HWM), Green Supply Chain Management (GSCM), Interpretive Structural Modeling (ISM)

I. INTRODUCTION

Hospitals and dispensaries in India have generated massive wastes creating an alarming situation for local governments. The waste generated by hospitals can be hazardous, toxic and even more harmful due to the presence of microorganisms in sufficient concentration that could result in transmission of infectious diseases. Pollutants from these wastes that can cause undesirable effects on human health have been identified. Two such pollutants the mercury and dioxin have been detected in significant amount in air and ash emissions from medical waste incinerators [2]. Globally, hospital waste issues have been seriously considered and many efforts have been done or are being done at international level to minimize hazards associated with hospital wastes. In India, this problem has been recognized by the concerned agencies, and Government regulations have been framed to systematize implementation [3]. To obey with government regulations and to increase their public image hospitals in India are adopting green supply chain practices to address waste issues. Organizations facing competitive, regulatory and community pressures, are trying to address their serious environmental issues by greening their supply chains which aims at elimination or minimization of waste in all forms including energy emissions, chemical, hazardous and solid waste, along supply chain [4]. Green Supply Chain Management (GSCM) has gained popularity with both academics and practitioners with objectives of reducing waste and preserving the quality of product-life and the natural resources.

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By lowering the environmental risks and impacts, as well as raising the ecological efficiency, organizations can achieve profit and market share objectives [5]. It represents integrating environmental thinking into supply chain management, including product design, material sourcing and selection, manufacturing processes, delivery of the final product to the consumer as well as end-of-life management of the product after its useful life [6].

It is clear from the above definition of GSCM that waste management practices are part of GSCM activity.

II. LITERATURE SURVEY

A. Hospital waste

The Medical Waste Tracking Act of 1988 defines medical waste as "any solid waste that is generated in the diagnosis, treatment, or immunization of human beings or animals, in research pertaining thereto, or in the production or testing of bio-logical". Medical waste can be identified by one of four different categories: infectious, hazardous, radioactive, and general. Infectious waste describes waste that has the possibility of causing infections to humans. It can include human or animal tissue (blood or other body parts), blood soaked bandages, discarded surgical gloves, cultures, stocks, or swabs to inoculate cultures. Much of this category, including human or animal tissue, can also be labeled as pathological waste, which can only be treated using specific methods. Pathological waste is either proven to contain pathogens, or could be perceived as containing microorganisms. Hazardous waste describes waste that has the possibility to affect humans in non-infectious ways. This type of waste includes sharps, which are generally defined as objects that can puncture or lacerate the skin, but can include needles and syringes, discarded surgical instruments such as scalpels and lancets, culture dishes and other glassware. Hazardous waste can also include chemicals, both medical and industrial. Some hazardous waste can also be considered infectious waste, depending on its usage and exposure to human or animal tissue prior to discard. Old drugs, including chemotherapy agents, are sometimes hazardous. Radioactive waste describes waste resulting from nuclear medicine treatments, cancer therapies and medical equipment that uses radioactive isotopes. Pathological waste that is contaminated with radioactive material is treated as radioactive waste rather than infectious waste. General waste makes up at least 85% of all waste generated at medical facilities, and is no different from general household or office waste, and includes paper, plastics, liquids and any other materials that do not fit into the previous three categories.

The World Health Organization classifies medical waste into: sharps, infectious, pathological, radioactive, pharmaceutical wastes.

B. Problems Associated with Hospital Wastes

Hospital waste causes a risk for patients and workers who handle these wastes. It is infectious and hazardous and poses serious threats to environmental health and requires specific treatment and management prior to its final disposal [7]. Improper disposal practices of hospital waste affects the people who come in direct contact with it. Waste loads also attract a variety of disease carriers, including mosquitoes and flies [8]. It can cause environmental pollution, unpleasant odors, and growth of

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insects, rodents and worms; it may lead to transmission of diseases like typhoid, cholera, HIV, Tuberculosis, Hepatitis B and C through injuries from sharps contaminated with human blood [9]. Moreover antibiotics poured down the drain can kill beneficial microbes and bacteria in septic systems and dumping of hospital waste in uncontrolled areas can have a direct environmental effect by contaminating soils and underground water. During incineration, if no proper filtering of flue gases is done, air can be polluted causing illnesses to the nearby populations [10].

C. Hospital Waste Statistics in India

Hospitals are one of India's largest sectors, in terms of revenue and employment, and the sector is expanding rapidly. In India, there are about 6,00,000 hospital beds, over 23,000 Primary Health Centers, thousands of registered nursing homes, countless unregistered nursing homes and dispensaries, and above all a very large number of quacks practicing at every nook and corner of urban and semi-urban locality [12]. Rapid increase in population, increase in life style disease and growth of medical tourism are some of the causes of growth of this sector. The private sector accounts for more than 80% of total healthcare spending in India [11]. According to health information statistics 20% of total beds are in rural hospitals while 80% are in urban hospitals. Extrapolating from past figures of number of beds and average quantity of waste generation at the rate of 1 kg per bed per day, it is estimated that about 0.33 million tonnes of hospital waste is being generated per year [3].

D. Hospital Waste Management (HWM)

Hospital Waste Management Healthcare waste management includes all activities involved in waste generation, segregation, transportation, storage, treatment and final disposal of all types of waste generated in the hospital facilities, stages of which require special attention [10]. In India, with exception to a few large hospitals, most of the smaller hospitals and nursing homes lack any effective system to safely dispose of their waste. Wastes generated during health services, the used bandages, syringes, human tissues, used culture media containing microorganisms are dumped in the open bins on the roadsides or directed into the water bodies. Thus, an unauthorized reuse of medical wastes by rag pickers is being promoted through irresponsible dumping of these dangerous wastes into open bins [23] and in turn facilitates in spread of many diseases. World Health Organization (WHO) predicted that India is on the verge of having an HIV epidemic. Tuberculosis (TB) and HIV combined together is taking great toll on the human health and life.

E. Previous Studies

Major research on waste management practices in hospital sector has been carried out by number researcher in countries such as Finland [13], Tanzania [14], Netherlands [15], Saudi Arabia [16] and United States of America [17], [18].

While most of the studies discuss harmful impact of improper waste management and status of current practices in Indian hospitals [19], [8], [20], [21] very few studies analyses the issues and identifies various barriers to waste management practices in Indian hospitals[3], [12]. Here an attempt has been made here to identify the potential barriers hindering the strength of waste management practices in Indian hospitals.

III. BARRIERS TO WASTE MANAGEMENT PRACTICES IN INDIAN HOSPITALS

Due to the serious situation involving biomedical waste management, the Ministry of Environment and Forests, Government of India created the Biomedical Waste (Management and Handling) Rules, which came into effect on 20th July, 1998 [20]. Despite these rules and initiations, a lot of challenges to hospital waste management practices are faced by Indian health care sector. The major challenges identified from literature review are: be polluted causing illnesses to the nearby populations [10].

A. Lack of Segregation Practices (LOSP)

Segregation practice prevents non-infectious waste to get mixed with infectious waste. Lack of segregation practices significantly increases the quantity of infectious medical waste as mixing of infectious component with the general non-infectious waste, makes the entire mass potentially infectious [8]. Poor segregation practice of the waste starting from generation to disposal is observed in Indian hospitals. In some hospitals though better segregation practices are followed at the point of generation, waste handlers are found mixing it together during the collection and results in loss of ultimate value of segregation [21].

B. Improper Waste Management Operational Strategy (IWMO)

Operational plans should include the location and capacity of the storage containers, frequency of collection for various types of wastes and schedule of activities. Infectious wastes are to be stored in the designated color-coded leak-proof containers for safe handling and can be disinfected / sterilized by the available facility in the hospital. After disinfection/sterilization the waste is transported to a common treatment facility, such as an incinerator or controlled landfill [3]. Studies show Indian hospitals have poor operational strategies as personnel responsible for these activities are mainly ward attendants and other supporting staff [12], and absence of documented waste management and disposal policy [21].

C. Insufficient Support from Government Agencies (ISFGA)

Support and guidance from government agencies in the areas of waste management, regulations in the form of waste reduction and recycling targets, carbon credit earnings, development of minimum energy efficiency standards for equipments are necessary for prevention of pollution and reduction of environmental load on sustained basis. No agency in India has been assigned the task of spreading awareness [12]. Therefore Rules have not been publicized as widely as required. Hence, smaller hospitals may not be fully aware of them. Additionally a number of issues have not been dealt with in detail, such as standards of collection and storage devices, equipment, etc. [3].

D. Lack of Green Procurement Policy (LOGPP)

Waste minimization in hospitals can be achieved by purchasing reusable items made of glass and metals which

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can be disinfected and reused [3]. For example, a polyolefin intravenous (IV) bag does not contain chlorine, so it has less possible to produce dioxins through incineration than an IV bag containing polyvinyl chloride (PVC) [2]. Similarly mercury thermometers can be replaced with mercury free thermometers. Hospitals should stimulate the purchase of environmentally preferable products by mandating certain practices in their purchasing policy.

E. Unauthorized Reuse of Health Care Waste (URHCW)

Reuse of plastic syringes and other plastic material used in the hospital is a booming business of billions of Indian Rupees. More than one million people are engaged in rag picking. Profitable regulatory returns and lack of awareness about the problems associated with biomedical wastes encourage waste-picking and reusing activities. The waste collection and transportation workers in the hospital segregate the recyclable material for sale. In a similar way, all disposable plastic items, needles and glass are segregated by the waste-pickers, from where the waste is deposited either inside the hospital grounds, or outside in the community bin [3].

F. Lack of Top Management Commitment (LOTMC)

Top management in most of Indian hospitals is showing disinterest in dealing with the waste problem. The wastes are therefore instead of being segregated, discharged in a mixed condition to the site of disposal, separating only the saline bottles, which are sent for auctioning [21].

G. Lack of Adequate Facilities (LOAF)

The facilities for storage, collection, treatment and disposal of hospital wastes as well as appropriate technologies have so far been limited in India. Additionally, adequate and requisite number of hygienic landfills is lacking in India. Therefore, the biomedical waste are openly dumped into the open bins on the road sides, or they are directed into the water bodies; through which severe disease causing agents are spread into the air, soil and water [23]. Autonomous onsite treatment methods may be suitable for large hospitals but are uneconomical for smaller institutes. An acceptable common system should be in place which will provide free supply of color coded bags, daily collection of infectious waste, and safe transportation of waste to offsite treatment facility and final disposal with suitable technology [19].

H. Financial Constraints (FC)

In most of the hospitals, financial provision is necessary for capital and repetitive expenditure including funds for adequate manpower, disinfectants, devices and equipment. Normally, a separate allocation of funds for waste management is not found in Indian hospitals. Additionally funds are required for conducting training and awareness programs for hospital employees. Smaller hospitals ignore waste management practices due to financial constraints [19].

I. Inadequate Awareness and Training Programs (IAATP)

Awareness of proper handling and disposal of hospital wastes among health personnel is a priority; it is necessary that everyone should know the potential health hazards. Regular programs will help prevent exposure of hospital wastes and related hazards. Notice display, proper labeling, and explanation by staff are effective methods. Seminars and workshops, and participation in training courses are also essential [23].

IV. INTERPRETIVE STRUCTURAL MODELING(ISM)

ISM is interpretive as the relation between the variables are decided based on the judgment of the selected group of experts, and it is structural as an overall structure can be extracted from the complex set of variables based upon their relationship. ISM is intended for use when desired to utilize systematic and logical thinking to approach a complex issue under consideration. It can act as a tool for imposing order and direction on the complexity of relationships among the variables. ISM is primarily intended as not only a group learning process, but can also use individually [1], [22]. ISM is a powerful technique, which can be applied in various fields.

Steps for constructing ISM based model are as follows:

A. Structural Self-Interaction Matrix (SSIM)

ISM methodology recommends the use of the expert thoughts based on various management techniques such as brain storming, nominal group technique, etc. in developing the contextual relationship among the variables [1]. In this study, experts from the hospitals were consulted in finding the nature of contextual relationship among the barriers of waste management practices in Indian hospitals. In order to analyze the relationship among the HWM barriers, a contextual relationship of 'leads to' type is chosen. For example, Inadequate Awareness and Training Programs lead to Lack of Segregation Practices. In a similar manner, the contextual relationships between the variables are developed. Keeping in mind the contextual relationship for each variable, the existence of a relation between any two variables [i (column) and j (row)] and the associated direction of the relation are questioned. Four symbols are used to denote the direction of relationship between the variables (i and j):

- V: Barrier i will help to alleviates barrier j
- A: Barrier j will be alleviated by barrier i
- X: Barrier i and j will help to alleviate each other
- O: Barrier i and j are unrelated.

Based on the contextual relationships, the SSIM is developed for the 9 variables identified as barriers of the HWM practices in Indian hospitals shown in Table I.

TABLE I

STRUCTURAL SELF INTERACTION MATRIX

Barriers T	9	8	7	6	5	4	3	2	1
1.LOSP	А	А	0	А	0	0	А	V	Х
2.IWMO	А	Α	Α	Α	Α	Α	Α	Х	А
3.ISFGA	V	Х	V	А	V	V	Х	V	V
4.LOGPP	0	Α	0	Α	V	Х	Α	V	0
5.URHCW	0	А	А	А	Х	А	А	V	0
6.LOTMC	V	V	V	Х	V	V	V	V	V
7.LOAF	0	Х	А	А	V	0	А	V	0
8.FC	V	Х	V	Α	V	V	Х	V	V
9.IAATP	Х	А	0	А	0	0	А	V	V

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B. Reachability Matrix

The SSIM is transformed into a binary matrix, called the initial reachability matrix by substituting V, A, X and O by 1 and 0 as per the case. The rules for the substitution of '1's and '0's are as follows [1]:

- If the (i, j) entry in the SSIM is V, then the (i, j) entry in the reachability matrix becomes 1 and the (j, i) entry becomes 0.
- If the (i, j) entry in the SSIM is A, then the (i, j) entry in the reachability matrix becomes 0 and the (j, i) entry becomes 1.
- If the (i, j) entry in the SSIM is X, then the (i, j) entry in the reachability matrix becomes 1 and the (j, i) entry becomes 1.
- If the (i, j) entry in the SSIM is O, then the (i, j) entry in the reachability matrix becomes 0 and the (j, i) entry becomes 0.

Following these rules, initial reachability matrix for the HWM barriers is identified and the final reachability matrix is attained by combining the transitivities, this is shown in Table II. In this table, the driving power and dependence of each variable are also shown. The driving power of a particular variable is the total number of variables (including itself), which it may help to achieve while the dependence is the total number of variables, which may help to achieve it.

TABLE II

REACHABILITY MATRIX

Barriers T	9	8	7	6	5	4	3	2	1	Driving
1	0	0	0	0	0	0	0	1	1	2
2	0	0	0	0	0	0	0	1	0	1
3	1	1	1	0	1	1	1	1	1	8
4	0	0	0	0	1	1	0	1	0	3
5	0	0	0	0	1	0	0	1	0	2
6	1	1	1	1	1	1	1	1	1	9
7	0	1	0	0	1	0	0	1	0	3
8	1	1	1	0	1	1	1	1	1	8
9	1	0	0	0	0	0	0	1	1	3
Dependence	4	4	3	1	6	4	3	9	5	

C. Level Partitions

From the reachability matrix the reachability and antecedent set for each variable are attained. The reachability set for a particular variable consists of the variable itself and the other variables, which it may help to achieve. The antecedent set consists of the variable itself and the other variables, which may help in achieving them. Then, the intersection of these two sets is derived for all variables. The variable for which the reachability and the intersection sets are the same, is assigned as the top-level variable in the ISM hierarchy as it would not help to achieve any other variable above their own level. After the identification of the top-level element, it is discarded from the list of remaining variables. From Table III, it is seen that the Improper Waste Management Implementation Strategy (variable 2) is found at level I. Thus, it would be positioned at the top of the ISM hierarchy. This iteration is repeated till the levels of each variable are found out. The identified levels aids in building the digraph and the final model of ISM (Table III).

D. Formation of ISM-based model

The structural model is developed from the final reachability matrix and the digraph is drawn. Removing the transitivity, the digraph is finally converted into the ISM model as shown in Fig. 1. In this developed model, the top level barriers (level I, here), are positioned at the top of the digraph and second level barriers occupy the position below the top level barriers. Similarly other barriers are positioned in the hierarchy according to their levels until the bottom level barrier (level V, here), is positioned at the lowest position in the digraph. Lack of Top Management Commitment (variable 6), having level V (highest level), have highest driving power and is positioned at the bottom of the hierarchy. It has a potential to drive the barriers Insufficient Support from Government Agencies and Financial Constraints, directly. Similarly the barriers Insufficient Support from Government Agencies (variable 3) and Financial Constraints (variable 8) lead to the variables Lack of Adequate Facilities, Lack of Green Procurement Policy and Inadequate Awareness and Training Programs, which are placed above them in the hierarchy. These variables lead to the variables placed immediately above them in the ISM hierarchy.

TABLE III

Barriers	Reachabil	Antecedent	Intersectio	Level
	-ity set	set	-n	
1	1	1,3,6,8,9	1	Π
2	2	1,2,3,4,5,6,7	2	Ι
		,8,9		
3	3,8	3,6,8	3,8	IV
4	4	3,4,6,8	4	III
5	5	3,4,5,6,7,8	5	II
6	6	6	6	V
7	8	3,6,8	8	III
8	3,8	3,6,7,8	3,8	IV
9	9	3,6,8,9	9	III

LEVEL PARTITION (ITERATION I-V)



Fig. 1 ISM- based hierarchy

IV. DISCUSSION

Green Supply Chain Management (GSCM) has been extensively approved and executed by various sectors to reduce environmental impact of their operations for gaining better trademark image and competitive advantage. With the increasing concern that waste produced by the hospitals' own the threat of causing environment hazard as well as serious health hazards, hospitals are trying to implement GSCM practices to address their waste issue. The barriers discussed above are identified as having the possible to obstruct HWM practices. Lack of Top Management Commitment is the barrier which is positioned at the bottom of hierarchy representing that it is the most important barrier, that this barrier can affect the impact of all other barriers. Similarly the barriers Insufficient Support from Government Agencies and Financial Constraints being occupied lower position in the hierarchy have an indication that these have significant obstructing impact on HWM. Position of the barrier Improper Waste Management Implementation Strategy on top of hierarchy indicates that it is the lowest noteworthy barrier and it is being exaggerated by all other barriers situated under it in the hierarchy.

V. CONCLUSION

Hospitals produce huge quantity of waste in the process of providing services to mankind. There is a vital need for raising awareness and education on medical waste concerns. This study has made an attempt to identify various challenges faced by Indian hospitals for managing their waste properly and confirming health and environmental safety. This data would be particularly helpful as a guideline for improving and developing the hospital waste management standard criteria in India. The hierarchy will help the decision makers to choose their hierarchy of actions that will enhance their resource utilization.

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