



PRODUCTION ENGINEERING ARCHIVES

ISSN 2353-5156 (print)
ISSN 2353-7779 (online)

Exist since 4th quarter 2013
Available online at www.pea-journal.eu

Waste Management Integration with Green Quality Function Deployment (G-QFD) for Healthcare Centre

Shubham Joshi¹, Payal Bhargava²

¹ Industrial Engineering and Management, Sri Aurobindo Institute of Technology, Indore (M.P.), ORCID ID: 0000-0001-8452-7632, e-mail: joshi.shubh88@gmail.com

² Department of Mechanical Engineering, Sri Aurobindo Institute of Technology, Indore (M.P.), ORCID ID: 0000-0003-2142-5852

Article history

Received 01.03.2019
Accepted 20.03.2019
Available online 15.04.2019

Keywords

Waste Management
QFD

Abstract

High doses of medical waste evidence that health waste management is problematic. A case study was conducted at various health institutions. This research analyzes various issues in the area of medical waste management. The research examines the perception of staff regarding medical waste management. The purpose of the study is to investigate the level of knowledge, attitudes and role of health practitioners in the management of medical waste.

Here the quality index and the environmental index of two health centers are studied; one is a private hospital and the other one a state hospital and compares these two indices with a questionnaire.

To provide environmentally friendly services, customers and environmental criteria have to be taken into account in the decision-making process and distributing the Green Quality Function provides a very useful way to achieve this goal.

DOI: 10.30657/pea.2019.22.09

JEL: L23, M11

1. Introduction

According to an old saying, "Purity is near godliness". The essence of this is duly captured by the Dravidians who, in 5,000 BC, highlighted the urban planning and safe and efficient sewerage systems to dispose of all the solid and liquid waste generated by the population. They were, actually, the pioneers in terms of scientific waste management.

Modern hospitals and healthcare institutions, including research centers, use a wide variety of drugs, including antibiotics, cytotoxic, corrosive chemicals, radioactive substances, which, eventually, become hospital waste. An access to hospitals has led to its negative consequences, namely, insufficient recycling, unauthorized and unauthorized re-use and increased waste. All the technological advances have led to increased availability of health-related consumer goods, which are prone to destruction.

The issue of inadequate management of the Waste Hospital in India was first highlighted in a petition written by the High Court of Respect; and then, in accordance with court guidelines, the Ministry of Environment and Forests, the Govt. of India on July 27, 98 announced Bio-Medical Waste Management (Management and Management Regulations); according to the provisions of the Environmental Act 1986. These rules have been adapted to regulate the imposition of

various categories of Bio-Medical Waste as defined herein; to ensure the safety of staff, patients, the public and the environment.

2. Literature review

Quality Function Deployment

The QFD concept was started in Japan by Yoji Akao in 1966 (Costa et al., 2000). QFD was created by Professor Mizuno in 1972 to design supertankers at the Kobe site of Mitsubishi, Japan (A Shahin et al., 2005; Martins and Aspinwall, 2001). Toyota, the world's leading manufacturer and its suppliers have developed it. Since 1972, its use has increased very rapidly; it accomplished a competitive edge in cost and quality time.

In 1978, the first book on the subject was published in Japanese, which led to a huge increase in the use of QFD in Japan. Until 1986, a survey of the largest number of companies in the Union of Japanese Scientists and Engineers (JUSE) showed that more than half used QFD.

Masao Kogure and Yoji Akao presented the QFD in the US in the article "Quality Department of Quality and CWQC in Japan", which was presented in Quality Progress in the 1983 edition (Bier and Cornesky, 2001; Han et al., 2001). Among the first experiment with QFD is Ford Motors; who used it to

plan the transmission assembly and Chrysler to develop cars like Neon. Xerox and Ford began to use QFD in the United States in 1986. 15 years after its US debut, QFD has been widely applied in industries such as aviation, software engineering, construction and marketing, and multinationals such as IBM, HP, Gebrens Motors, AT & T, Digital Equipment, ITT, Baxter Healthcare, Texas Instruments, Miliken Textile, Black and Decker and Philips International have approved their benefits (Prasad, 1996).

Developing a successful product in today's competitive and globalizing environment should carefully consider customer requirements when designing the product. To this end, the Department of Quality Functioning (QFD) has been widely studied and implemented to better understand and utilize the needs of consumers in the development of new products. The Quality Management Division (QFD) is a general concept that helps convert customer needs into the right technical requirements for each stage of product development and production.

QFD Process

QFD should be seen from a very global perspective as a methodology that a company will associate with its clients and will help the organization in its planning processes. The purpose of QFD is not to build matrices but to touch the client and use this knowledge to develop products that satisfy the customer and use different matrices.

The priority items selected by the matrix during the analysis are the items that will improve the level of customer satisfaction in a measurable way. Therefore, there is more emphasis on customers and an increase in awareness of their needs. Due to this focus, the process leads to customer understanding and to the growth of customer satisfaction.

The basic structure of the QFD process is regulated around the following points:

- Entering the QFD planning matrix is the customer's voice. The matrix cannot start until the client requests are met. Their needs and needs are known. This also applies to internal planning projects as well as products and services to be sold to the market client.
- The initial matrix is usually the product design matrix. Customer requirements are data. Subsequent matrices can be used to set or "flatten" the selected product planning matrix for part planning and process planning. Some forms of production planning or matrix can be used to import critical product and process requirements from previous matrices.
- The main purpose of the QFD process is to assist in the organization and analysis of all relevant information about a project and to use the process to assist articles that require priority attention. The QFD process will help focus on the areas that need special attention.

Green QFD

Environmental issues have been introduced to the development of new products especially since the 1990s. The terms that are commonly referred to are eco-design or environmental design. Eco-design can be defined as product

development involving environmental concerns, taking into account the environmental requirements that allow for the reduction of environmental impacts in the product life cycle (Bakker, 1995). To improve the environmental aspects of products, a number of practices are considered as simple methods, tools and guidance for more complex techniques, such as life cycle management (Bovea and Wang, 2007).

Among the eco-design practices, some of them fit into the methods and tools that are already available in the product development knowledge body. One of the methods and tools that have emerged in the literature is QFD (establishing a quality function). There have been a large number of publications in 'environmental QFD' over the past ten years when compared with other methods and tools. One of the major advantages of using QFD in eco-design is the ability to review environmental requirements while developing a new product by translating those requirements into design specifications (Masui et al., 2001). Despite the benefits of ecological design methods, some authors argue that new products are not always better in environments (Ritzen and Lindah, 2001), and ecological practices do not necessarily apply to product development (Knight and Jenkins, 2009). In this sense, this paper tries to analyze a number of publications suggesting ecological design methods based on QFD. To do this, a systematic review of literature has been made. Twelve search ranges related to the terms 'QFD and eco-design', 'environmental design' and others were used to search 7 databases. As a result, 17 QFD-based methods published between 1993 and 2009 have been identified.

Medical waste treatment technologies

The review of the literature on waste management /waste treatment technologies is quite contradictory. Some of the most common technologies include

- (1) Incinerators
- (2) Sterilization or autoclaving
- (3) Irradiation
- (4) Sterilization
- (5) Microwave,
- (6) Chemical disinfection
- (7) Secured Landfill.

According to previous studies (Park and Jeong, 2001, Lee et al., 2004), 49 to 60% of medical waste is treated by different incinerations, 20 to 37% by autoclave sterilization and 4 to 5% by other procedures. . The main processes currently used are sterilization by autoclave combustion and combustion. Each of the above technologies has advantages and disadvantages.

Combustion uses thermal energy to break down waste into incombustible residues or into ashes and vapors. Fly and soil residues produced after the incineration of medical waste contain a high proportion of heavy metals such as lead, cadmium, nickel, copper, copper and zinc. Guidelines (Valavanidis, 2008). Medical waste is the third source of atmospheric emissions of dioxin. However, despite public concerns about incinerators, this option is the most commonly used because of the benefits of sterilization of pathological and anatomical wastes, volume and mass reduction, and energy recovery (Zhao et al., 2008).

Autoclaving / Sterilizing: is the second most common waste management technology. The process involves waste at deadly temperatures that infect and possibly kill pathogens. (Armstrong et al., 2010). Autoclaves are considered more expensive than incineration (Jang et al., 2006). One of the biggest obstacles to autoclaving is that the size of the waste introduced into the system is not reduced. Landfills that still cause many environmental threats many studies show that autoclave shredders are the best alternative to treating medical waste (Armstrong et al., 2010, Brenda et al 2010).

The microwave process uses radiant energy to kill infectious agents by converting this energy into heat and pressure. The crushing is generally combined with a microwave oven 22.

A Combined Microwave Field - Small Combustion Technology is the most cost-effective and environmentally friendly treatment technology. (Lee et al., 2003) The effectiveness of microwave disinfection may be a problem of microwave performance.

In chemical treatments, chemicals such as chlorine, formaldehyde, ethylene oxide, etc. are used. Use as a disinfectant. Once again, the effectiveness of disinfection is questioned as it depends on temperature, pH and surface area (Road, 2005).

The above literature shows divergent views on the treatment of medical waste. In this literature, the difference between the types of waste studied must be taken into account. The components of the wastes examined are different, indicating that the best treatment should be selected according to the characteristics of the waste. With proper reduction of waste and chlorine-containing waste, the introduction of mercury into the incinerator can reduce the environmental impact of the medical waste incinerator. Although none of the alternative technologies is completely safe, they can be combined with an effective waste reduction and separation program to reduce the environmental impact and financial costs of providing medical waste.

Environmental, health and economic criteria must be taken into account in the criteria for evaluating technological opportunities (Batterman, 2004). The best medical waste treatment technology differs from one hospital to another. This may depend on local conditions and hospital requirements. However, WHO provides a list of factors that determine the choice of the best medical waste treatment technology (Pruss, 1999). They are:

- Disinfection efficiency
- Volume and mass reduction.
- Quantity of waste for treatment.
- Infrastructure Requirements.
- Options available for final disposal
- Review of operation and maintenance
- The location and location of the treatment site and the storage facility
- Admissibility of the public
- Available space
- Investment and operating costs

- Health and environmental aspects
- Waste types to be treated and disposed of
- Regulatory requirements
- Considerations for occupational safety
- Training requirements

It is, therefore, clear from the literature that the disposal of medical waste is important because of the large amount of medical waste, the irregular separation and the different views the various technologies. Medical waste management is an area that requires more research and studies to adapt it to sustainability.

3. Methodology Implications

The methods specifically chosen relate to the objectives and objectives of the research study presented in Table 1. Here, qualitative interviewing and participatory observation data are combined with quantitative study material to test the arguments that:

- Waste management policies should be aimed at reducing waste.
- Health workers' perspective towards medical waste management is critical for effective separation and minimization of waste.

Table 1. Methodology for Research

Objective	Methods	Output
Collect primary data and understand current services provided by hospitals A and B and expire management policies and practices in A and B.	1. Questionnaire for patient, contractor and personnel examination, administration 2. Maintenance with the waste manager. 3. Work Visits / Attendance	Observation. 1. Current services provided by hospitals A and B 2. Current Waste Management Policy 3. Waste generation data. Information on disposal of medical waste
Understand the perception of staff in managing medical waste management	1. Observation of Participants 2. Quantitative Survey 3. Follow the questions	Employee interest in medical waste management. 1. The level of welfare versus current segregation practice. 2. The problems facing workers in the current segregation system. 3. Attitude of training and improvement of waste management. 4. Personnel perception of different treatment technologies.
Compare available Hospital A and B Waste Management	Services and Technology Application of the QFD and QFD Green Model in two hospital A and B	Comparison of Quality Indexes in Hospital A and B

Application of Method

In this section, QFD and green QFD method are applied in two different hospitals (A and B) and the result of two houses in quality index and green index are compared.

Development of quality house for hospital A and B

From the customer demand and questionnaire survey following aspects are the subject of the study

- Economical
- Transportation of the patient,
- Hospital hygiene,
- Medical qualifications
- Selection of hospital staff,
- The location of the hospital
- Hi-tech

The development of greenhouses for the waste disposal of hospitals A and B depends on the customer's wishes

- Safety at work,
- Harmless To Living Environment,
- Environmental-Friendly,
- Departmental Training,
- Easy To Manipulate,
- Existing Waste Management System

Table 2. Comparison of Quality House of A and B on the Basis of Customer Demand and Questionnaire Output

Customer demand	Questionnaire survey output for A	Questionnaire survey output for B
Economic	1	5
Hospital transport	2	1
Hospital hygiene	4	2
Qualification of doctors	5	3
The attitude of the hospital staff	4	3
Hospital location	2	2
Modern technologies	5	2

4. Result & Discussion

After the implementation of the discussed methods, the result obtained from two different health care centers regarding their services in respect to customer demand through QFD and hospital waste management through green QFD are summarized here.

Quality function deployment house on basis of questionnaire survey perform in two hospital A and B in respect to customer demand as discussed earlier are shown that quality index in hospital A is better than hospital B (as described in table 4 given below).

Green QFD house on basis of questionnaire survey for waste management system in the form of environmental index in

two hospital A and B is studied and concluded that hospital waste management system in hospital A is better than hospital B (as describe in table 3 given below):

Table 3. Comparison of Green House for A and B on the Basis of Customer Demand And Questionnaire survey

Customer demand	Questionnaire survey output for A	Questionnaire survey output for B
Safety at work	5	4
Harmless to habitat	4	2
Respect for nature	3	2
Training Division	3	3
Easy to handle	4	2
Current waste management system	3	2
Easy to handle	4	1

Table 4. Comparison between Ei and Qi of Hospital A and B

	Quality Index	Environmental Index
Hospital A	378	708
Hospital B	348	463

As per the information gathered with respect to table 2 and the results obtained in table 4, it is observed that the Quality index and the Environmental index both are much higher than that of other hospital. Therefore, the services provided by Hospital A must be considered.

REFERENCES

Armstrong, B.A., Reinhardt, P.A., 2010. *Managing laboratory biomedical waste using a large on-site autoclave-shredder*. Journal of Chemical Health and Safety, 17(6), 33-39.

Bakker C, 1995. *Environmental information for industrial designers*, Technische Universiteit Delft

Batterman, S., 2004. *Findings on an Assessment of Small-scale Incinerators for Health-care Waste*. World health organization, Geneva, 2004, 1-65.

Bier, I.D. and Cornesky, R., 2001. *Using QFD to construct a higher education curriculum*. Quality progress, 34(4), 64.

Bovea, M.D., Wang, B., 2007. *Redesign methodology for developing environmentally conscious products*. International Journal of Production Research, 45(18-19), 4057-4072.

Costa, A.I.A., Dekker, M., Jongen, 4. 7. 4. W. (2000). *Quality function deployment in the food industry: a review*. Trends in Food Science & Technology, 11(9-10), 306-314.

Han, S.B., Chen, S.K., Ebrahimpour, M., Sodhi, M.S., 2001. *A conceptual QFD planning model*. International Journal of Quality & Reliability Management, 18(8), 796-812.

Jang, Y.C., Lee, C., Yoon, O.S. and Kim, H., 2006. *Medical waste management in Korea*. Journal of environmental management, 80(2), 107-115.

Knight, P., Jenkins, J.O., 2009. *Adopting and applying eco-design techniques: a practitioner's perspective*. Journal of cleaner production, 17(5), 549-558.

Lee, B.K., Ellenbecker, M.J. and Moure-Ersaso, R., 2004. *Alternatives for treatment and disposal cost reduction of regulated medical wastes*. Waste management, 24(2), 143-151.

Martins, A., Aspinwall, E.M., 2001. *Quality function deployment: an empirical study in the UK*. Total Quality Management, 12(5), 575-588.

Masao, K., Yoji, A., 1983. *Quality Function Deployment and Company Wide Quality Control in Japan: a strategy for assuring that quality is built into products*. Quality Progress, 16(10), 25-29.

Masui, K., Sakao, T., Inaba, A., 2001. *Quality function deployment for environment: QFDE (1st report)-a methodology in early stage of DfE*.

- In Proceedings Second International Symposium on Environmentally Conscious Design and Inverse Manufacturing, IEEE, 52-857.
- Mizuno, Y., Kaneko, C., Oikawa, Y., Ikeda, T., & Itoh, T. 1972. *Novel synthesis of purine. beta-D-nucleosides via purine 8, 5'-S-anhydronucleosides*. Journal of the American Chemical Society, 94(13), 4737-4739.
- Park, H.S., Jeong, J.W., 2001. *Recent trends on disposal technologies of medical waste*. Korean Society Solid Waste Engineering Soc, 18(1), 18-27.
- Prasad, B., 1996. *Concurrent engineering fundamentals* (Vol. 1). Upper Saddle River, NJ: Prentice Hall PTR.
- Prüss-Üstün, A., 1999. *Safe management of wastes from health-care activities*. World Health Organization.
- Ritzén, S., Lindahl, M., 2001. *Selection and implementation-key activities to successful use of EcoDesign tools*. In Proceedings Second International Symposium on Environmentally Conscious Design and Inverse Manufacturing, IEEE, 174-179.
- Shahin, A., 2005. *Quality function deployment: A comprehensive review*. Department of Management, University of Isfahan: Isfahan, Iran, 1-25.
- Valavanidis, A., Iliopoulos, N., Fiotakis, K. and Gotsis, G., 2008. *Metal leachability, heavy metals, polycyclic aromatic hydrocarbons and polychlorinated biphenyls in fly and bottom ashes of a medical waste incineration facility*. Waste Management & Research, 26(3), 247-255.

废物管理与医疗中心的绿色质量功能部署（G-QFD）相结合

關鍵詞

废物管理
QFD

摘要

高剂量的医疗废物证明健康废物管理存在问题。在各种卫生机构进行了个案研究。该研究分析了医疗废物管理领域的各种问题。该研究调查了员工对医疗废物管理的看法。该研究的目的是调查医疗从业人员在医疗废物管理方面的知识水平，态度和作用。研究了两个卫生中心的质量指标和环境指标；一个是私立医院，另一个是州立医院，并将这两个指数与问卷调查进行比较。为了提供环保服务，必须在决策过程中考虑客户和环境标准，并且分配绿色质量功能提供了实现这一目标的非常有用的方式。
