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RESEARCH ARTICLE

USING FACTOR ANALYSIS TO IMPROVE ENVIRONMENTAL MANAGEMENT SYSTEMS IN THE PUBLIC HOSPITALS

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ABSTRACT

This paper aims to improve the environmental performance by reducing the harmful environmental impacts produced by daily activities to the hospitals. Based on the analysis of the major obstacles to the application of the environmental management system in public hospitals. The research problem demonstrates there is a lack of environmental performance in this hospital because of several difficulties in the implementation of the environmental management system. Which, it has a direct influence upon staff, patients, and their family. So, healthcare organizations need to follow the right health methods to protect the hospital staff from the risks arising from the hospital's activities.

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INTRODUCTION

Hospitals' aims to provide healthcare services and treatments patient on time (Grol&Wensing 2020), through a set of activities and processes (Mujanet *al.*, 2019; WHO, 2017). These activities generate a lot of waste in the environment includes a broad range of materials, from used needles and syringes to soiled dressings, diagnostic samples, blood, body parts, patient organic waste, pharmaceuticals, chemicals, medical devices, hazardous medical waste, and radioactive materials (Sepetis & Kada, 2009; Nkechi *et al.*, 2013; WHO 2011). Which have a direct impact on the environment that has negatively influenced human healths (Sepetis & Kada, 2009; Eckelman & Sherman, 2016).

In the context of the history of the rise of environmental management, Rachel Carson was the first to bring the world's attention to the environment after the publication of her book *Silent Spring* in 1962, based on the atomic explosions that caused massive damage to the environment in 1955 (Lytle, 2007; Kroll, 2001). In 1968, the United Nations General Assembly proposed a conference on environmental problems (Handl, 2012). Since 1970, attention to environmental management problems has appeared after an increase in human interaction with the environment, and the

impact of industries on the environment has increased greatly (Barrow, 2006). In 1972, the *Environment Conference* was carried out in Stockholm, Sweden, which identifies the concept of the environment, and how human beings exploit the material and social resources available to achieve their goals (McAdam, 2017; Rhyner, 2017). In 1987, the *Independent Commission on the Environment*, which introduced the concept of sustainable development, found the environment in which the organization operates, including air, water, land, natural, human, animal, plant, and interrelated relationships (Chu & Karr, 2017; Schuler *et al.*, 2017). In 1992, the British Standards Organization (BS 7750) derived from quality specification 5750 (Çalış, & Büyükakıncı, 2019; Goodwin, 2016; Heras-Saizarborria *et al.*, 2018). In 1994, the Environmental Management Specification issued by International ISO (Wilson & Campbell, 2020).

The EMS policies includes effective information systems that provide regulatory requirements, annual performance reports, activities schedule, and emergency plans (Christini *et al.*, 2004). Most organizations use environmental management systems to achieve many benefits to develop an index of impact, improve environmental performance, maintain compliance with environmental regulations, reduce total environmental costs, train workforces, maintaining compliance with environmental regulations, reduction in legal

responsibility and risks (Christini *et al.*, 2004; Matthews *et al.*, 2004). In fact, Sepetis&Kada, (2009) confirmed in his study that there is no effective environmental management system in most hospitals. Although, there are attempts to take mandatory environmental measures (Sepetis & Kada, 2009). In addition, Fiksel (1996) study indicated that measures of environmental performance contribute effectively to continuous improvement and achievement of environmental goals. For example, parameters are necessary to support the goal, preparation, control, and continuous improvement of product design (Christini *et al.*, 2004). Environmental issues can be identified according to the type of products/services. This procedure includes all stages starting from inputs, processes, and outputs (Todd, 2009). Accordingly, plan strategies must be developed to limit the impact of these organizations on environmental damage. Regulations and environmental protection laws are also stated. Although the organizations have adopted pollution control measures, they have not made any changes in the products and final processes of manufacturing. It also carries out such measures because of fear of sanctions and legal and social duties. It is often in order to maintain their market share and to reduce closer monitoring by environmental protection organizations (Todd, 2009). For this reason, the social responsibility of the health care sector requires the adoption of an effective EMS that contributes to environmental protection and preserves the general health of a person.

RESEARCH PROBLEM

This study was identifying the majority of issues that obstacles to applying environmental management systems at *Al Karkh General Hospital*. Which is concerning with administrative, financial, and other aspects. The research problem had determined by identifying research questions: -

1. Does the hospital administration have knowledge of the environmental management system and its environmental challenges?
2. What are the obstacles to applying the environmental management system and improving environmental performance in the hospital?

METHODOLOGY

An analytical exploratory approach was adopted to achieve the research objectives. The questionnaire had designed according to the conceptual framework of the component matrix model. That consists of five key variables that have a direct impact on identifying obstacles to implementing the environmental management system in hospitals, as shown in Figure (1). That includes five key components were:

1. Support for senior management to implement the requirements of the environmental management system at the hospital.
2. Implement legislation, laws, and oversight systems to protect the hospital environment.
3. The effectiveness of applying an information system in the hospital's environmental management.
4. Knowledge and culture of top management and workers in the field of the environmental management system.

5. Time and budget required for applied environmental management systems

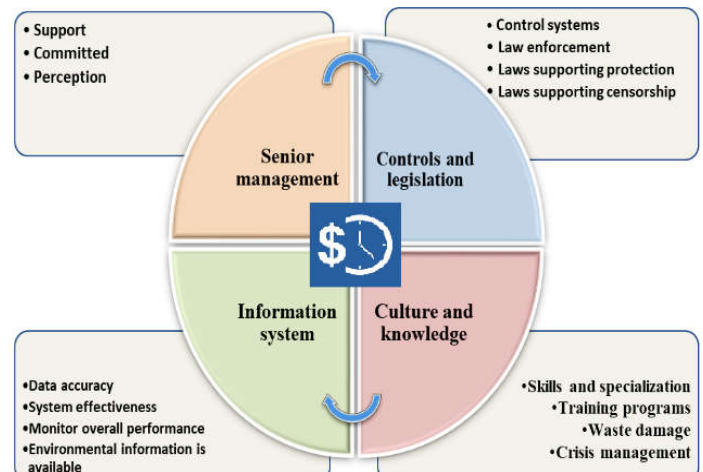


Fig. 1. Illustrated a component matrix

The research questionnaire had consisted of (23) questions that included the research variables and their sub-factors. The factor analysis of the questionnaire had carried out according to its sequence of dimensions. The validity and reliability of the questionnaire were verifying. This study targeted senior-level managers, executive managers, and expert workers. Quantitative statistical methods had used to analyze collected data. Where the factor analysis method was used to determine the acceptable ratios to the main factor by analyzing the Component Matrix and Rotated Matrix. Then, the Alpha (Cronbach) coefficient was used to measure the accuracy of the research questionnaire.

ENVIRONMENTAL MANAGEMENT SYSTEM

An Environmental Management System (EMS) arises because of human beings' activities and their relationships with the physical environment and biological systems (Sroufe& Joseph, 2017). It focuses on objective analysis that ensures keep and controls continue developing technology without any change in the natural system (Eckelman & Sherman 2016). Also, EMS is defined by the United Nations as 'developing environmental plans and policies that contribute to monitoring and assessing the environmental impacts produced by the industrial project. It includes all stages of production, from obtaining raw materials to the final product and the extent to which each staged has an impact on the environment. It also efficiently implements regulatory procedures, taking into account the costs and tax implications involved (Yakubu, 2017). The success of the implementation of the EMS contributes to achieving the environmental performance goals of any organizations and promotes sustainable development, which includes (Alshuwaikhat and Abubakar, 2008; Rondinelli, and Berry, 2000):

- The environmental objective is the overall environment protection goal created by environmental policy. Which, it is developed by the organization to verify its applicability and evaluation.
- Environmental policy is the organization's statement that described its objectives and principles related to comprehensive environment performance. It also

includes the work structure and an organization's responsibility toward the environment.

- The environmental management system is part of the overall management system. It includes organizational structure, planning activities, responsibilities, practices, procedures, and processes. In addition to the resources related to the development of environmental policy, its application, and improvement. Its review and protection of environmental regulations and laws.
- Measurement and evaluation, the measuring methods and monitoring had considered as the main activities required for the assessment of environmental performance.
- The environmental management system needs to be reviewed periodically to determine the extent to which its implementation is consistent with the planned objectives.
- Improve environment performances, the ISO 14001:2004 standard has been known as a renewed process to develop an environmental management system to achieve improvements in overall environmental performance by an environmental policy.

The ISO 14001 Standard defines a minimum set of requirements for environmental management that an organization must have effectively implemented to achieve registration. Which can help companies focus on continually improving their environmental performance and controlled through its EMS. This EMS provides a structured framework to effectively manage environmental risks and issues and provide a process to initiate improvement. Shell's EMS is an embedded system in its broader health, safety, and environment management system (Crowe et al., 2003). In the context of the healthcare sector, the new environmental policies adopted in each Health Care Unit voluntarily plan environmental managerial strategies. The tools of voluntary environmental management strategies, as the international system of environmental management ISO 14001 and the European system EMAS1, are applied gradually by hospitals (Sepetis, 2019; Sepetis et al., 2020).

HOSPITAL WASTE

World Health Organization and the US Environmental Protection Agency, there is around 10–25% of healthcare waste classified as hazardous or special waste (Eleyan et al., 2013). Even the percentage of these wastes appears to be low compared to general waste. Nevertheless, it contains a higher level of risk to human beings' health and the environment. Because it has infectious and harmful material waste can influence human beings' health. It contains carcinogenic, genotoxic waste, pathological waste, chemical waste, pharmaceutical waste. Other types have waste with high heavy metal content and pressurized containers, as well as radioactive waste (Eleyan et al., 2013). Usually, this risk depends on healthcare waste management practices. As it has health risks that directly affect the lives of hospital staff and other people whose daily deals with health waste. For example, the level of the risk that affected the environment due to Portugal Hospitals activities reported were (4.24) for the risk of healthcare staff, (4.08) for the waste workers, (3.29) for the patients, and (2.80) for the visitors (Ferreira and Teixeira 2010).

The healthcare sector aims to provide high-quality health services first, without taking into account the type of energy used and its harmful effects on the environment as cited by NHS England (2013). In general, indicated that the majority of the hospitals are considered as a great energy user with unique requirements for operation hospital facilities like heating, cooling, powering, and medical equipment running (Ziebig and Hoinka 2013). Mostly that is operating theatres and treatment rooms. That has led to increased gas emissions. For example, the energy used for heating and power is responsible for 12% of all UK greenhouse gas emissions (DECC 2011). So, the social responsibility of the health sector requires the adoption of measures that contribute to reducing the impact of harmful emissions to the environment. Research maintains the quality of health service delivery to patients and without increasing costs by adopted clean energy that it has considered environmentally-friendly as refer by Carbon Trust (2010). Therefore, hospitals need to adopt reduction strategies for harmful gas emissions. This strategy enables to balance between health care service (Morgenstern et al., 2016). The hospital had indicated as a major reason for the exposure of heavy fecal contamination due to the ways for disposal of sewage into rivers and nonagricultural soils. Consequently, it produces antibiotic-resistant bacteria in the community. Then, it influence proliferate in soil and surface waters, persist, and spread in different environments (Novais et al., 2005). For example, general waste gas had produced due to health care daily activities. It has estimated around 75–90% of the types of waste. The municipality and wastewater can dispose of this type of waste. It has considered somewhat not dangerous and does not require any suffering in handling and special treatment. Sewage pollution resulting from poor disposal of patients' sewage waste, which contains enterococci (Eleyan et al., 2013).

HEALTH CARE WASTE MANAGEMENT

Waste management Hospitals need to design a system for treating and disposing of health care waste, whether these are general or hazardous waste. This system contributes to reducing the impact of this waste from environmental pollution, safety, and ensure reliable healthcare of both human health and the environment (Eleyan et al., 2013). This system contributes to reducing the impact of this waste from environmental pollution and safety. It also ensures offers reliable healthcare of both human health and the environment. An effective waste management system enables to sort of medical waste according to the nature of the materials and the risks (Tudor et al., 2005). It is difficult of controlling solid waste management in developing countries compared with an industrialized country for several reasons like the novelty of the medical technologies used, the difference in the location of health care, and the size of the health services provided to patients, physical capabilities, resources, collection, transport, segregation, and storage (Harhay et al., 2009).

OBSTACLES OF THE APPLICATION EMS

Hospital management faces many constraints that limit the process of improving environmental performance due to the inability to implement the EMS effectively. Accordingly, administrative needs to identify these constraints in order to correct in time. The most important of these constraints are as follows (Babakri et al., 2003; Chan, 2011):

1. **Lack of role environmental control:** The absence of the role of monitor leads to damage to the environment resulting from human activities and industrial waste. Accordingly, It must support the monitor of environmental protection and the preparation of legal legislation on environmental protection.
2. **The lack of an effective EMS** is one of the challenges facing any organization. Making the right environmental decision is depends on the accuracy of the information available to the management of the organizations, which can save time, effort, and costs. It contributes to the timely identification and resolution of environmental problems, which contributes to the ongoing environmental changes.
3. **The lack of cooperation** between the industrial and service sectors and environmental protection organizations leads to the inability to address and reduce environmental problems.
4. **Lack of cultural and environmental knowledge** due to a lack of accurate information on environmental protection measures. Besides, the advice and guidance that contributes to reducing environmental pollution do not publish by the environmental protection organizations.
5. **Lack of rules and standards** that can use in an environmental audit of the organization that leads to ecological behavior.
6. The absence of the guideline and standard regulating ecological behavior means random disposal of environment resources to the point of lack of responsibility, whether it's civilian or ethical.

RESULTS AND DISCUSSION

Factor analysis for the matrix components: In this study, "seven factors" had examined by using the factor analysis method, which has direct control and distinguishing the questionnaire variables based on the Component Matrix and Rotated Matrix. The results of the variance analysis indicated that (82.99%) of total factors could control the principal factors. That has displayed accurate saturation ratios, as shown in Table 1.

Table 1. Analysis of the total variance of the components matrix roots

| Saturation values for the set of squares | | | Factor (roots) |
|--|------------------------|---------|----------------|
| Cumulative contrast ratio | Percentage of variance | Totally | |
| 16.044 | 16.044 | 3.690 | 1 |
| 29.237 | 13.199 | 3.035 | 2 |
| 42.382 | 13.145 | 3.023 | 3 |
| 55.030 | 12.648 | 2.909 | 4 |
| 66.518 | 11.488 | 2.642 | 5 |
| 75.233 | 8.715 | 2.004 | 6 |
| 82.991 | 7.758 | 1.784 | 7 |

As it appears from Table 1, the results of the analysis of the total variance of the roots of the component matrix of the research sample indicate a cumulative ratio of variance with repeatability (82.991%). That means (83%) of the sample components are at a very high overload rate. The data collected h analyzed by using the rotation matrix to investigate the possibility of obtaining higher saturation rates. Therefore,

the optimal solution had found through a large number of strength factors that have been nominated by the rotation matrix, without the need to adopt the matrix of components. Which will be explained in the analysis of the questionnaire paragraphs later.

Top management commitment: Based on a matrix of components, a quantitative analysis aims to examine the support and commitment of the hospital's senior management in the application of the Environmental Management System (EMS). The results of this study showed that the top manager and the executive's knowledge and experience in the environmental management system. They are seeking to support its implementation in the selected hospital, as shown in Table 2.

Controls and legislation: A second component in the matrix examined was controls and legislation. As appear in Table 2, in general, all hospital activities are subject to regulatory monitor to ensure they are not damaging to the environment. Also, the hospital administration uses all efforts, legislations, legal and primary provisions to support the oversight role towards environmental protection.

Information system: The result in the following Table 4 had indicated although the monitoring hospital performance relied on the feedback provided by the environmental information system that achieves environment goals. But, this system still inefficient in applying the current EMS in the hospital. Therefore, it needs a long time to implement.

Health organization culture and knowledge: Environmental responsibility is one of the main activities scheduled within the strategies and culture of health organizations (Carlini et al., 2019; Baughn et al., 2007). That follows the Environmental Protection Instruction Manual and discuss its problems (Dögl and Holtbrügge, 2014). It aims to become environmentally friendly by focusing on reducing the impact of the company on the environment (Dögl and Holtbrügge, 2014; Babiak & Trendafilova, 2011). This study focused on measuring the level of information and culture of managers and employees about the EMS in the selected hospital. In addition to the extent of their cooperation in implementing the EMS and helping them reduce environmental risks. The factor analysis of the EMS variables in the hospital proved there are (3) variables out of (23) variables tested did not obtain the required saturation ratios. There are (13%) of the variables of this study matrix limited the application of the EMS in the hospital. That includes measuring the hospital's level of knowledge and culture about EMS was (X13, X14, and X18). Accordingly, the hospital should try to increase the knowledge and culture of hospital administration and workers about the importance of implementing the EMS and its future benefits for the individual, the community, and the environment, as shown in Table 5.

Time and budget: The results of the study showed that implementing the EMS in the hospital needs a long time due to its required to offer an expensive budget, as shown in Table 6. Actual costs and profits in hospitals by the implementation of environmental administrative policies. That includes a public environmental administrative policy cost for urban medical waste and dangerous medical waste, separation, packing, and

Table 2. The optimum solution according to top management commitment

| Variable recognition | Top management commitment | Saturation ratio | Optimal solution |
|----------------------|---------------------------------------|------------------|------------------|
| X1 | Knowledge and skill about the EMS | 0.814 | Accepted |
| X2 | Supports efforts to implement the EMS | 0.724 | Accepted |
| X3 | An obligation to provide resources | 0.636 | Accepted |

Table 3. The optimum solution according to the controls and legislation

| Variable recognition | Controls and legislation | Saturation ratio | Optimal solution |
|----------------------|--|------------------|------------------|
| X4 | All hospital activities are subject to regulatory controls to ensure they are not damaging to the environment. | 0.808 | Accepted |
| X5 | Compulsory legislation and instructions are available to protect the environment. | 0.608 | Accepted |
| X9 | The hospital administration is committed to applying special legislation to protect the environment. | 0.764 | Accepted |
| X19 | The hospital administration uses all efforts, legislations, legal and primary provisions to support the oversight role towards environmental protection. | 0.474 | Accepted |

Table 4. The optimum solution according to the information system

| Variable recognition | Information system | Saturation ratio | Optimal solution |
|----------------------|--|------------------|------------------|
| X10 | In monitoring performance, the hospital relies on the feedback provided by the environmental information system that achieves environmental goals. | 0.856 | Accepted |
| X17 | Inefficiency in applying the current EMS in the hospital. | 0.744 | Accepted |
| X20 | Availability of accurate and timely information that contributes to making the right environmental decision. | 0.723 | Accepted |
| X21 | There is coordination between environmental protection organizations and the hospital. | 0.574 | Accepted |
| X22 | Environmental information is available that contributes to coordinating relations between organizations, environmental protection and hospital. | 0.757 | Accepted |

Table 5. The optimum solution according to the knowledge and culture

| Variable recognition | Knowledge and culture | Saturation ratio | Optimal solution |
|----------------------|---|------------------|------------------|
| X6 | Hospital staff have specialization qualifications in the EMS. | 0.583 | Accepted |
| X7 | There are ongoing training programs in the EMS. | 0.585 | Accepted |
| X8 | The hospital has a plan to develop employees' knowledge about EMS. | 0.766 | Accepted |
| X11 | The hospital is interested in carrying out internal operations and activities more than solving environmental problems. | 0.697 | Accepted |
| X12 | The hospital managers believe that rivers and oceans is the best way to solve environmental pollution. | 0.696 | Accepted |
| X13 | Hospital waste leads to pollution and environmental damage. | -0.863 | Not Accepted |
| X14 | The local population is causing huge environmental pollution. | -0.869 | Not Accepted |
| X18 | The hospital staff was exposed to health risks due to the hospital's activities and operations. | -0.892 | Not Accepted |
| X23 | Human errors in the use of chemical and medical materials lead to environmental pollution. | 0.944 | Accepted |

Table 6. The optimum solution according to the time and budget

| Variable recognition | Time and budget | Saturation ratio | Optimal solution |
|----------------------|--|------------------|------------------|
| X15 | The implementation of the EMS in the hospital needs a long time. | 0.599 | Accepted |
| X16 | The implementation of the EMS requires an expensive budget. | 0.768 | Accepted |

Table 7. Shows the effect of environmental management system variables at the hospital according to the factor analysis

| Vs | Overloading | Level | Vs | Overloading | Level |
|-----|-----------------|-------|-----|-----------------|-------|
| | Factor Analysis | | | Factor Analysis | |
| X1 | 0.814 | 3 | X13 | 0.863- | 21 |
| X2 | 0.724 | 10 | X14 | 0.869- | 22 |
| X3 | 0.636 | 14 | X15 | 0.599 | 16 |
| X4 | 0.808 | 4 | X16 | 0.768 | 5 |
| X5 | 0.608 | 15 | X17 | 0.744 | 9 |
| X6 | 0.583 | 18 | X18 | 0.892- | 23 |
| X7 | 0.585 | 17 | X19 | 0.474 | 20 |
| X8 | 0.766 | 6 | X20 | 0.723 | 11 |
| X9 | 0.764 | 7 | X21 | 0.574 | 19 |
| X10 | 0.856 | 2 | X22 | 0.757 | 8 |
| X11 | 0.697 | 12 | X23 | 0.944 | 1 |
| X12 | 0.696 | 13 | | | |

disposal of waste, education, and means of staff protection, volunteer environmental managerial policies cost, costs of energy, supply, and recycling administration of the hospital, cost of operational change according to the Environmental, and other potential environment costs (Sepetis and Kada, 2009). In conclusion, the quantitative statistical analysis shows in Table (7) that all variables have achieved a sufficient saturation percentage, which exceeded (30%). However, these variables have a different position in terms of the extent applicable to EMS in the selected hospital. The variable (X23) came first (Human errors in the use of chemical and medical materials lead to environmental pollution), with a saturation rate of (0.944). While, the variable (X18) ranked twenty-third (Hospital staff exposed to health risks due to the hospital's activities and operations), with a saturation rate of (-0.892).

CONCLUSION

The results show, there are many obstacles that limit the application of the EMS in public hospitals. Which led to the inability to improve environmental performance. Based on the senior management leaders at healthcare organizations need to adopt new policies that contribute to protecting the environment from pollution from hospital operations. The study also emphasizes the necessity of using clean, environmentally friendly operations processes to reduce pollution rates resulting from hospital activities and treat health waste. Educating workers in health care organizations and the general public about the importance of protecting the environment and how to reduce pollution rates by following the right methods in treating health care waste. Where individuals contribute directly to environmental pollution and damage due to the lack of awareness and culture about environmental protection. Legislation and regulations to protect the environment must be developed and published periodically for health care workers and the general public. Furthermore, healthcare organizations need to follow the right health methods to protect the hospital staff from the risks arising from the hospital's activities. It needs to classify according to the level of risk. This study referred that hospital staff had been exposing to health risks due to hospital activities and operations. This study is considered significant in the health sector and its effect on reducing environmental pollution resulting from hospital activities. Also, it can be to apply in the industrial sector in the future.

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