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## Article

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## Renewable Energies and their Advantages for the Sustainability of Companies in the Health Sector

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### ABSTRACT

The main purpose of the article is to analyze from an integral perspective the main contributions that this technology has in the health sector, as an initiative to adapt its management to the moment of ecological need that is lived all over the world. A descriptive qualitative approach is proposed, using documentary analysis techniques. To this end, an exhaustive review of the recent literature on renewable energies and their potential application in the health sector is carried out. As part of the results, the dramatic situation of the generation of hazardous and non-hazardous waste from operations in the health sector is highlighted, as well as some viable initiatives that can be implemented in order to reduce these effects. The revised literature constitutes a good part of the recent publications on the subject, however, it did not cover all the scientific articles, therefore, it does not constitute a unique vision of the current situation of the management of renewable energies in the health sector. The article is aimed at responding to a globally recognized problem that is affecting not only human life, but also the various ecosystems that cohabit on the planet.

**Keywords:** Renewable Energy, Health Sector, Environmental Management, Hazardous Waste, Green Hospitals

**JEL Classifications:** Q42, Q48, G17

### 1. INTRODUCTION

Today, the problems generated in ecosystems and public health create the need for the development of concepts applied in processes such as sustainability, creation of projects for efficient management of resources, clean production and new laws that apply in all business sectors that generate countless amounts of waste, and negative impacts on the planet. One of them is the health sector, which manipulates chemical elements, biological risk, environmental and according to the figures are causing high levels of pollution. Sustainability is part of the development of a local community, and humanity in general, which promotes the development of projects without compromising future generations, there, the human being, must be directed to the achievement of

business objectives and development of their activities in a safe and responsible way with the environment. The recycling of inorganic and biodegradable waste, solar energy plants, wind energy, sustainable facilities and other renewable ventures, are part of the alternatives that this sector implements for the continuous improvement of its processes in the inclusion of new practices that contribute to the environment (Mohanty, 2012; Rodriguez, Castillo and Palma, 2018).

Thus, the renewable energy sector has brought great economic savings in health entities who have considered the investment of this resource, necessary as an alternative to sustainability (Ferroukhi et al., 2013). In addition to other benefits in reducing energy consumption from fossil fuels such as oil, coal and gas, the

main emitters that influence climate change and have been used in this sector due to the configuration of the energy system formed by the industrialized world (Trainer, 2013). The development of ICT has positively influenced the implementation of business management systems, including the environment. Virtual media are a source of savings for countless documents, reports, papers that were previously necessary to print. The availability of dynamic information is also another benefit in the training of health personnel, which requires good practices in their processes. This shows the need to study in depth the methods used and the current panorama that characterizes the environmental practices in the health sector, as well as the knowledge of the rules that govern the sector.

## 2. MATERIALS AND METHODS

The epistemological sustenance of the study is based on the guidelines of the emerging paradigm, exposed by Pines (2019) as a current in scientific research that has been transforming as the ways of explaining reality advance. In this regard, authors such as Martinez (2011) point out that phenomena are dynamic and constantly changing, therefore, the complexity involved in reducing their interpretation to simple data may not be a reliable method for understanding in depth the context of a particular problem. From this perspective, the environmental difficulties that the planet is going through and the low use of renewable energies in the health sector is a multidimensional problem that must be approached taking into consideration different positions, in order to find the best options to solve a situation as complex as the one presented. Based on this approach, a qualitative approach is used to investigate the current situation of environmental management of companies in the health sector and the characteristics, advantages and sustainability that can provide renewable energy.

According to Ritchie's ideas et al. (2013) the qualitative approach allows the researcher to use a set of tools to extract information from the facts from different sources and thus explain them with parameters that go beyond numerical or purely statistical measurements. Likewise, Noble and Smith (2015) consider that the validity and reliability provided by these techniques is as solid as those guaranteed by quantitative methods. For this reason, a documentary design is proposed that includes the application of content analysis techniques to extract meanings from the literature, to understand how the environmental management of health companies is currently being developed and the potentialities offered by renewable energies. For Ahmed (2010), the review of publications is based on the identification of ideas, reflections or data presented by the authors to give an interpretation that leads to the construction of new theoretical positions, all ensuring aspects such as authenticity, credibility and understanding of documents.

By virtue of the above, scientific articles and reports of international organizations recognized in the subject are analyzed. To this end, an exhaustive review of the literature presented by databases such as Emerald, Scielo, Scopus, was through their web portals was carried out. As selection criteria for these documentary sources, priority is given to those published in the last five years, preferably in both English and Spanish, belonging to mainstream journals. At

the same time, the resulting publications were organized in a matrix where metadata such as title, year, authors, objectives, methods, results and main contributions were observed, in order to erect their own vision enriched with the reflections of the researchers participating in the present study.

## 3. RESULTS

### 3.1. Renewable Energies: Characteristics and Advantages

Energy efficiency and the implementation of coefficients contribute to the optimization of the energy consumed in the health sector, without affecting the well-being of the services provided by the entities (Hernández and Jiménez, 2018). These alternatives allow the conservation of the services and products provided, but with the advantage that they allow the reduction of toxicity in emissions (Morffi, 2016). The challenges that come with renewable energies are autogeneration, the creator in the business sectors of prosumers, which include intelligent methodologies for energy use (UPME, 2015).

Among the global ventures that promote energy efficiency are in Africa, the Hospital of Misericordia, located in Serra Leona, which designed a hybrid photovoltaic-diesel system to reduce operating costs, between 37% and 64% depending on the weather. In Iraq, a photovoltaic project was proposed for a health sector entity whose daily load consumes approximately 31.6 kWh. Through optimization software, it was estimated that the photovoltaic system is economically, technically and for preservation viable (Dos Santos, Jabbour, 2013).

The impact on the environment due to the inappropriate use of waste is a cause for global alert and concern in all business sectors, including the hospital sector due to the high health risk generated by the final disposal of the waste used. Elements such as glass, needles, scalpels, and other sharps, require safety in their final destination at the end of their functional usefulness, these procedures are important in the prevention of biological and environmental risks. The classification method, the contractor company and other aspects are important for the management of waste management of hospital entities (González, Arroyo, del Río, 2017). The United States generates the greatest amount of contamination with the food sector, followed by the health sector, since hospital waste and high CO<sub>2</sub> consumption classify the country as a generator of between 3 and 8% of the carbon footprint due to the dependence on fossil consumption as fuels for electricity generation, in the United States (Bambarén, Alatrística, 2014).

Los países en desarrollo han desatendido el problema de gestión de los desechos, y los de mayor cuidado, los llamados residuos infecciosos son responsabilidad directa del personal de la salud, para un desempeño óptimo de su gestión ambiental (Kumar, Somrongthong, Shaikh, 2015). The clinical hospital in Porto Alegre, one of the most important in southern Brazil, receives approximately 16,000 people a day. The hospital in commitment to its environmental practices, was proposed from 1990 the separation of waste and lower consumption of electricity. The environmental practices have improved continuously, even in

2010, the hospital made an investment of \$700 thousand reais, in infrastructure and HR in its environmental management, making it a model for promoting environmental awareness for other hospitals, which uses colors in garbage containers to encourage not only employees, but the community in general, of the classified disposal of resources (Martini et al., 2017).

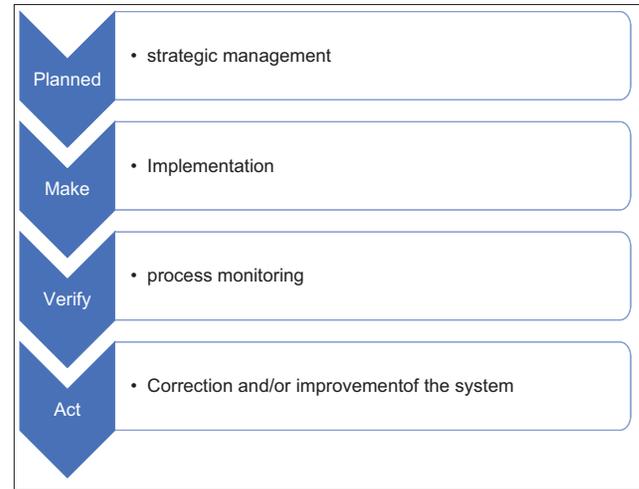
Hamadan and Kermanshah provinces, located in Iran, in search of the measurement of wastewater processing and disposal in their hospitals considered the study of 35 hospital centers that included the public and private sectors. The results generated showed that, of a total of 19 hospitals in Kermanshah, only seven hospitals have wastewater treatment with their own plant, five hospitals do not operate and seven have deficits in their treatment systems. In Hamadan, of a total of 16 hospitals only six contain wastewater treatment, while the rest do not have a treatment system, the negative is that this wastewater reaches wells, and urban wastewater becomes a polluting factor uncontrolled by state entities of those hospitals that operate without compliance with minimum standards of health (Azizi et al., 2016).

All these factors such as the inadequate disposal of hospital wastewater, lack of treatment plants make it necessary to implement management regulations before the entities that provide services in the health sector are closed, based on ISO 14000, which includes processing policies applied to the issue of liquid waste and its proper destination in pursuit of the proper elimination of environmental impact generated by polluting water available in urban places and that can come into contact with any human being, and at the same time causes a disease that endangers life (Azizi et al., 2016).

For the implementation of best practices of the environmental management system generated in hospitals it is first recommended a general evaluation or diagnosis of the practices that are carried out on a daily basis and that directly concern the environmental field, the provision of budgets that allow the assurance of the required resources, the training of senior medical officials, paramedics and leaders who control the good practices of middle and low ranks that have access to elements with high level of contamination. The active participation of those responsible for the execution of the system once planned and the education of stakeholders, including the training of the public (Toheed et al., 2013).

The model, proposed in Figure 1, shows the PHVA cycle, applied to the standard for implementation of the ISO 14000 environmental management system, as a reference framework that takes into account the socio-economic activities of the organization, interests and measures to be included according to a general diagnosis of the environmental impact of emissions into the air, water spills, discharges into the soil. Use of raw materials and energy, by-products and space (ICONTEC, 2015). Because of inadequate environmental management practices, losses and economic uncertainties are generated. This is more repetitive in the case of SMEs, where the total value of what is spent by the system cannot be determined, due to the lack of preparation and commitment by the leaders of the organization. Errors such as environmental costs

**Figure 1:** PHVA cycle applied to the ISO 14000 management system



accounted for together with operational costs put the control of resources at risk (Lucchese et al., 2018).

Research shows that the correct separation of waste, reduces the risks of contamination, for this, the collaboration of all, within a hospital organization, is a joint and indispensable task. The administrative area of entities such as the Cândido Fontoura Hospital, located in Sao Paulo, have adapted in their processes, training activities for the awareness of their employees, in the disposal of their waste, especially with waste such as paper, which are the most usable as a by-product in labor management (Zajac et al., 2016). In the Middle East, India, within a hospital of dental services, workers have knowledge of the subject of solid waste management, however, quality training is still required to have a better impact on the processes of disposal of hospital waste with intensive training programs (Sudeep et al., 2017).

In Portugal, in the area of intensive care, measures to reduce food waste are being studied. It is stipulated that hospitals dispose of large amounts of food waste and generate up to three times as much waste from other areas that require food services. According to the study conducted by Dias et al. (2015), a patient throws away 35% of her food, this represents 8,7 thousand tons of food wasted per year in Portugal, represented in 0,5% of the National Health Budget thrown in the garbage (Dias et al., 2015).

Within a study carried out in a public hospital in Peru, it was obtained that, of a total of 642 tons of solid waste produced, 58.4% was associated with common waste, while 40.5% corresponded to biocontaminants and 1.2% to highly contaminants. It was found that the waste generated exceeds the expected value in hospitals in Latin America, however, the value is lower compared to hospitals in the United States. Another comparative value was that, in hospitals in Lima, an even higher value of hazardous waste has been recorded with a total of 58% corresponding in a value of 57% to biocontaminants and 1% to highly polluting waste. This undoubtedly arouses great concern, in search of environmental practices that promote the reduction and control of the impact generated by health activities in the capital of Peru (Bambarén and Alatrística, 2014).

As hospital waste, mostly found in the hospital sector, Esalud and Hospital JAMO, in Peru, were found plastic bottles of serum, diapers and food waste, paper and cardboard, which shows that recycling is an opportunity in Peru, for the reuse of large quantities of waste discarded by the health sector (Carril and Vásquez, 2013). Tumbes, Argentina, has had problems with the management of its waste, in compliance with regulations, that is to say, in quantity and size of the containers that collect the waste, the respective signage, something really worrisome in the city hospitals is that there was evident ignorance regarding the regulations and lack of delegation of responsibilities corresponding to environmental preservation (Hernández and Lesino, 2007). The biological risks associated with hospital activities are infections, bacteria, viruses, protozoa, toxins, fungi and allergens, which make this sector one of the most critical if hygiene and prevention measures are not used. In the city of Bogotá, approximately 49 thousand tons of wastes were generated, only in hospital waste, which represent an environmental problem (Rojas, 2016).

In Colombia, the environmental management system implemented in companies in the health sector includes ISO 14000; however, there are other studies such as Life Cycle Analysis, Substance Flow, Environmental Risk Analysis, Environmental Impact Studies and Environmental Behavior Assessment, which allow the review, examination and consequently, control of variables that at first sight cannot be observed, for example, life cycle analysis, provides numerical data, emissions to the environment and a detailed report of the harmful effects that are transmitted in the environment in emissions (Rodríguez et al., 2016).

In Pakistan, studies have been carried out concerning the determination of the aspects of waste management in the largest hospital in the city through the use of software specialized in life cycle analysis, within the processes evaluated were found the transport of waste, disposal in places such as landfills, incineration, composting, the latter being the appropriate in generating less toxic because it is a natural method. According to the results, landfills and incineration brought the worst results. There is little information in the companies about the advantages of the analysis of the life cycle of the processes, therefore, it is important to make known that it is a very useful tool for the calculation of gases and emissions that would apply in processes such as solid waste management (Ali et al., 2016).

Hospital waste generally includes paper, food and packaging, the value of which can reach up to 80% of the total waste, however, in larger hospitals the amount of infectious waste reaches 40% of the causes of diseases such as hepatitis, and 12% of HIV (Figure 2), if the waste is exposed in the hospital environment without proper handling (Rojas, 2016). Among the environmental norms established in Colombia is Law 09/1979, which defines the importance of environmental sanitation, priority of attention to the population, and sanitary surveillance and control in the country (Rojas, 2016).

The solid waste management policy, updated through CONPES 3874, focuses on the prevention of waste generation and final disposal, to promote its reuse and exploitation (DNP, 2016).

Colombia has an Integrated Management Plan for hospital and similar waste (PGIRH), in search of the prevention and reduction of environmental impact also through the Manual of Integrated Waste Management, defines the characterization of waste generated in the health sector (Mora and Berbeo, 2010).

According to the information shown in Figure 3, sharps, animal and cytological residues are categorized as biohazardous residues, i.e., where there is a probability of exposure to harmful and health-endangering microorganisms, some of the sharps residues include limes, lancets, knives. Animal waste, generated by entities such as laboratories and the cosmetics sector and that cause infectious diseases, and cytotoxic waste or excess of drugs, chemicals and packaging. Chemical residues categorize the group of heavy metals, reagents, oils and radioactive elements. Biodegradable and recyclable waste, which can be used again and finally inert and ordinary waste such as napkins, paper packaging, coal, cloth, food packaging, among others (Mora and Berbeo, 2010).

In Colombia, the coupling of the use of hospital waste management, explained above, is outstanding, but still lacking, implementation of green areas in hospitals, more friendly structural designs that allow them to consolidate as green hospitals, which promise to be the best quality means of ecological sustainability in the sector making them more competitive and efficient. (Monroy et al., 2018). However, a model to follow for green building is the San Vicente Foundation located in Antioquia, whose building stands out for its automated control of energy consumption. This entity achieved LEED certification, which rewards innovative development and technologies implemented for better environmental performance (Uribe and Arboleda, 2015).

According to Figure 4, green buildings, proposed for projects such as the San Vicente Hospital, must be carried out through certain

Figure 2: Types of diseases generated by infectious waste

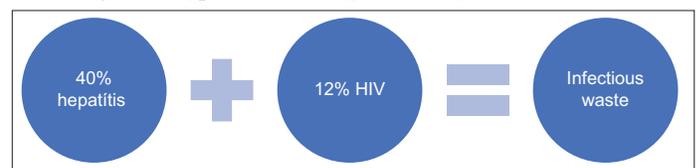
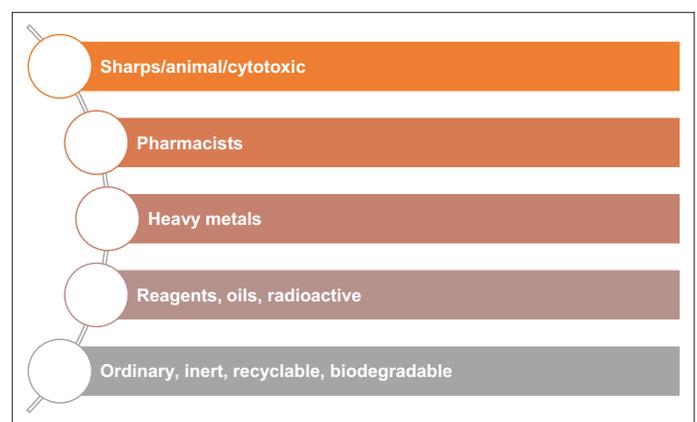


Figure 3: Classification of waste generated by the health industry in Colombia



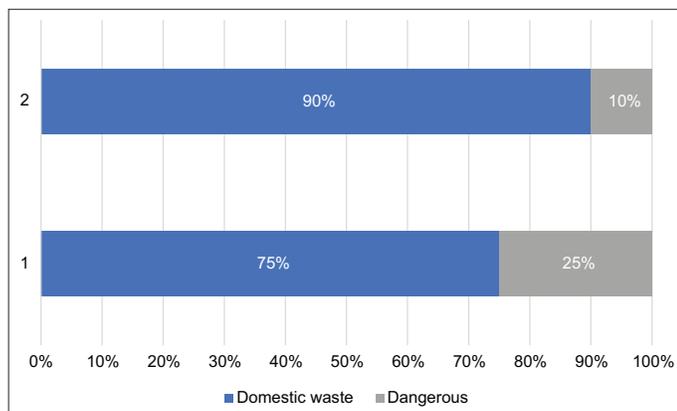
qualities of architectural design that guarantee the sustainability of the place, others such as quality and innovation through the efficient management of resources, such as energy, water, waste generated, and everything concerning the environmental impact (Hyytinen and Toivonen, 2015). In the structural design, the prevention of erosion and sedimentation, preservation of green areas, recovery of waste in the construction period, landscaping, among others, are taken into account. For the promotion of efficiency, many alternatives are proposed, including the use of recycled rainwater, low-consumption toilets, which increase the efficiency of water use, in the area of energy, measures such as sunbathing or natural ventilation, which are taken into account at the time of construction are projections that would reduce dependence on electricity by a significant percentage. Others such as the use of biodegradable elements for cleaning, eliminates promotes the use of biodegradable by-products. Quality and innovation are undoubtedly important to take into account in the planning of green building projects, which ensure the comfort, health and welfare of patients (Uribe and Arboleda, 2015).

It is estimated that Colombian hospitals categorized in the first three levels generate 5,560 tons of waste per year. Between 75% and 90% of the waste is domestic and between 10% and 25% is hazardous (Figure 5). According to the Ministry of the Environment, this percentage could reach 40%. In Latin America, it is considered that 5% of total generation corresponds to

Figure 4: Relevant Green Building Initiatives



Figure 5: Waste generated in hospital premises



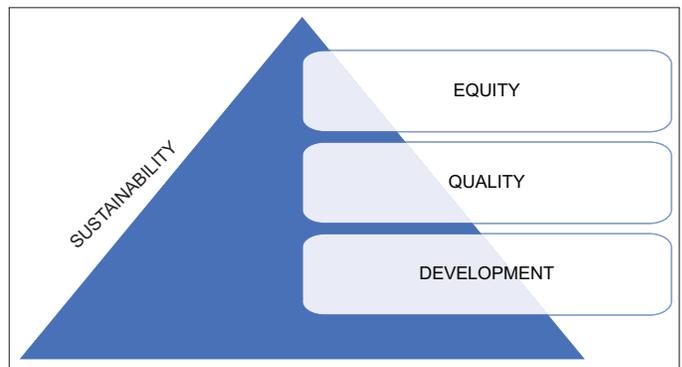
hazardous waste, 10% to pathogenic waste and 85% to ordinary waste (Rodríguez et al., 2016). The accelerated growth has generated an increase in the use of the planet's raw material, whose value in 1970 was 22,000 million tons, in 2010, tripled its value, so it is important within the environmental policy implemented in the country, the promotion of a citizen culture, which is not only on paper, but is developed as a goal in depth (DNP, 2016).

Colombia has commitments with international organizations such as the United Nations, in the fulfillment of Sustainable Development Objectives, which include objective 6, clean water and sanitation, 11 sustainable communities, 12 responsible consumption and production, which includes less generation of waste in the environment. However, recycling has been a subject underestimated by some organizations, due to the preference in the ease of obtaining raw material for first use, and its low cost (DNP, 2016).

In Figure 6, the terms of equity, quality and development are represented, if any of them does not exist, in a project, simply the existence of sustainability cannot be guaranteed. This term refers to the improvement of the environmental quality, constant search of the development and/or advance of a community, be it economic or technical and the equity that is sought in the creation of better alternatives of life (Jiménez et al., 2018). Projects such as environmental education strategies, the use of ICTs, the elimination of paper, ecological stations, the use of ecological utensils for patients, recycling of biodegradable waste are alternatives that should be promoted more frequently, the development of projects through universities and research groups should support the issue of solid waste, as has done the Autonomous University Corporation of Cauca with the Project Ecological Station based on energy (Flor et al., 2016).

With respect to the issue of biodegradable waste, if recycled, different by-products can be obtained, including fertilizers, organic products, ecological inputs, household products, aromatizers, animal consumption products, and useful raw material for different industrial processes. (Wang and Li, 2009), It is therefore important to classify and separate this waste, from the rest, in hospitals, and create new recycling undertakings to tackle the problem of excessive waste generation in the health sector, which would support objective 11 of sustainable communities (ICONTEC, 2006).

Figure 6: Factors affecting the achievement of global sustainability



Likewise, the recycling of biodegradable waste would generate raw material for other sectors such as cosmetics, cleaning, food, among others. One option against the excessive use of plastic packaging and premium paper is the undertaking of obtaining recycled paper through the use of organic waste. This industry must be supported. The purchase of recycled products of organic elements in good condition, should not be devalued for being second, on the contrary, has a higher value for the positive impact generated in the environment (Velandia and Valencia, 2015).

The standard that establishes the requirements for the efficient management of organic waste that can be derived from activities such as health, transformed into by-products such as fertilizers are stated in the NTC 5167, these requirements were designed to ensure that the product generated meets the minimum quality standards. Test methods are performed on its components and minimum analysis of the quantities required (ICONTEC, 2011). Placing solar heaters in hospitals is a renewable alternative for heating buildings in cold cities such as Bogota, Tunja, and reduce conventional energy consumption, according to figures, 45% and 55% of energy in a building is spent by heating and cooling systems. The models of solar heaters contain different efficiencies and prices, of which it is recommended to a greater extent, those of double step with an efficiency superior to 80% (Quiñonez et al., 2012).

In replacement of natural gas network and in tropical countries, with high irradiation, it is suggested the installation of heaters, these undertakings have been considered for the computational design of a public hospital, located in Susques, Argentina, in the procurement of the feasibility study for the implementation of solar heaters (Hernández and Lesino, 2007). Thanks to advances in technology and research, there are patents of great value, such as the invention of a machine that neutralizes the bacterial content of hospital waste and turns it into common waste (Salda et al., 2016).

#### 4. CONCLUSIONS

It is evident the environmental urgency that is lived in the XXI century at global level, however, there are undertakings, patents, projects, laws that, with the best availability of people and culture of use, would lead to progress in the quality of life of the population through the appropriate use of natural resources including water, energy and material used in the provision of services applied to the medical and health sector. Globally, even in industrialized countries such as the United States, the high consumption of fuels for the generation of electricity in the hospital sector that generates up to 8% of the carbon footprint. In Latin America, 85% of waste is ordinary, among the waste catalogued in this group are paper, plastic, rest of food, and others that can be recycled efficiently and be used as raw material for by-products from other sectors.

In Lima, Peru, according to the figures, hazardous wastes total 57% to biocontaminants and 1% to highly polluting wastes. The destination of this waste must prove possible preservation alternatives in scientific studies such as patents, which is responsible for neutralizing bacteria contained in polluting waste from the hospital sector. According to the figures found, more

than 50% of the waste determined for Colombian hospitals is for domestic and non-hazardous use, which generates opportunities for entrepreneurship and potential businesses in the recycling industry. This does not mean that the situation remains the same, the health sector must not only comply with the regulations established by the Integrated Waste Management Manual, but also, apart from day-to-day activities, measures must be taken to use only the necessary material in health activities and processes, promoting the saving of waste such as ordinary waste. Figures show, the proven waste of food, up to 35%, this denotes concern due to the lack of management with these lost resources that can serve in the eradication of extreme poverty and hunger, one of the Millennium Development Goals.

In Colombia, universities, research groups, public and private sector entities and the government must be constant support in the development of waste management ventures, a problem that falls on all interested parties and affects not only the current population but also future generations. Therefore, it is not enough that it only adapts to the fulfillment of the norms of an environmental management system concerning waste classification, it is of vital importance the development of innovation themes that allow technical-economic alternatives in front of the posed problems.

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