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GREEN BUSINESS PROCESS MANAGEMENT: AN URBAN SUSTAINABLE WATER RE-USE SERVICE FRAMEWORK IN SAUDI ARABIA

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ABSTRACT

Environmental sustainability has been one of the key factors, particularly when referring to water services in Saudi Arabia. Water wastage was a serious issue in Jeddah, Saudi Arabia. In addition, wastewater was released into the sea in Jeddah, which caused environmental pollution. Thus, this work has aimed to improve this situation by proposing urban sustainable water re-use service framework using Green Business Process Management (BPM) approach. The idea is to minimize the amount of wastewater by reusing and exploiting wastewater released into the sea. In this work, the functional requirement consists of four parts, which are preliminary wastewater treatment, BIOSOR: a peat-based system, sequencing batch reactors in wastewater treatment and UV disinfection wastewater treatment. Furthermore, the non-functional requirement consists of three parts, which are integrated sludge management system, cloud computing information system and Green BPM. The framework was designed with reference to UNICEF's framework. The proposed framework is expected to create a sustainable framework for the reuse of water services that work towards Saudi Arabia's 2030 vision.

INTRODUCTION

Water resources are one of the world's most important resources [1]. In metropolitan cities, which are centers of comprehensive evolutionary operations, accessibility of clean water in the necessary amount is a critical

issue. In addition, incompetence in the use of water supply may result in water wastage, resulting in much lack of sufficient water resources [2]. Water services must be well managed in order to be able to make full use of the resources available.

Water management can be achieved by reducing water losses and increasing the efficiency of water use. This can be done by adopting innovative irrigation techniques, water pricing policies, and reuse of marginal water [3]. Furthermore, Polprasert and Koottatep [4] stated that environmental conservation through water management is a very critical factor in society that reduces greenhouse gases (GHGs).

Cook [5] stated that most jurisdictions experience water scarcity either seasonally or continuously as a result of developmental pressure, increased water use and climate change. One of the suggestions made here is that wide-scale water reuse measures should be implemented, including water capture, greywater reuse, and recycled drinking water production [5]. Furthermore, Kummu et al. [6] stated that the main problems facing water scarcity in the 20th century were mainly high freshwater consumption, with continued population growth, climate change and revolutions in the behavior of water consumption. Furthermore, according to Iglesias and Garrote [7] water imbalance mostly occurs as a result of water being exploited by humans due to the high demands of water for agricultural purposes. Socio-economic factors such as population growth are the influence of this demand. Moreover, Wang et al. [8] analyzed the impacts of climate change on water demand and proposed a water management strategy that can help adapt to the growing pressure of water scarcity, as a result of climate change and socio-economic development. Abansi et al. [9] discussed recycling and reuse of gray waters. The findings of their work showed that grey water consists of 50-80 percent of the household wastewater. Thus, by recycling these grey waters, the sustainability of water supply can be enhanced [9]. Grizzetti et al. [10] stated that, irrespective of the interest of ecosystem service systems and water conservation, the actual implementation and management of these services is insufficient due to the lack of clear methodologies and practical definitions.

Water management is a huge challenge, especially in a country like Saudi Arabia, where there is drought and no major water resource other than seawater [11]. In addition, water sewage processes in Jeddah have been a problem in recent years, where wastewater is discharged into the sea causing pollution of the marine environment [12]. Thus, to overcome this issue, reuse of waste water should be considered. This is often ignored for many reasons, such as lack of awareness or analphabetism of the reuse of waste water and its benefits in maintaining water resources for longer periods and prioritized purposes [12].
Hence, the aim of this work is to improve the environment at Jeddah through green information systems practices which is known as green business process management (BPM). Thus, this work presents the development of urban sustainable water re-use service framework using green BPM approach.

FUNCTIONAL AND NON-FUNCTIONAL REQUIREMENTS

The wastewater treatment project is where different processes are used to convert wastewater into effluent with minimal environmental impact. In this regard, requirement specification and system analysis were conducted for the National Water Company (NWC) in Jeddah, Saudi Arabia.

The functional requirement is comprised of four parts, which are preliminary wastewater treatment, BIOSOR: A peat-based system, sequencing batch reactors in wastewater treatment, and UV Disinfection wastewater treatment. The non-functional requirement is comprised of three parts, which are integrated sludge management system, cloud computing information system, and in relation with Green BPM. The details of each functional requirement and non-functional requirement are presented in the following sub-sections.

Preliminary Wastewater Treatment

The NWC requirements with functional requirements are not satisfactory and fully efficient. For this reason, preliminary wastewater treatment is needed for screening and grit removal before actually going into the primary treatment phase. Wastewater screening removes coarse solid and equally rags that interface with equipment. Thus, removing grits from a solid material such as heavy metals and other inorganic items helps to increase the efficiency of wastewater treatment. In addition, the preliminary phase will help with satisfactory outcomes of treated water after the tertiary phase. Figure 1 shows the wastewater treatment phases (Preliminary phase).

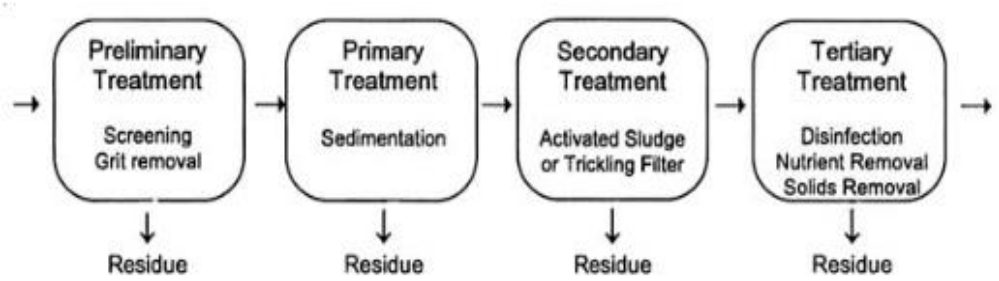

Figure 1: Wastewater Treatment Phases (Preliminary Phase)

BIOSOR: A Peat-Based System

The BIOSOR is a wastewater treatment model that ensures environmental protection during wastewater treatment. Bio filtration organic support is an environmentally friendly approach to wastewater treatment. In wastewater treatment plants, the functional requirement of bio filtration is installed. In this solution, peat, woodchips and other organic ingredients were filtered to obtain purity not only of water but also of air. Peat is an organic substance that replaces the soil, where a bog holds water (waste water) that absorbs most of the bacteria (microorganism) and carbon (NO2). The BIOSOR is an operating principle that combines liquid discharge gas and stream treatment. This solution is appreciated for its reliability, simplicity and low maintenance costs. BIOSOR's qualities are a passive system, remote monitoring, non-blocking

distribution system that is also odorless, and low impact on the community. Figure 2 shows the operation flow of BIOSOR.

Sequencing Batch Reactors In Wastewater Treatment

Sequencing batch reactors in wastewater treatment help improve treatment processes. NWC's existing system considers normal wastewater flow without any innovation in treatment processes. The batch sequencing reactors are activated sludge systems, whereas reactor tank treatment processes took place.

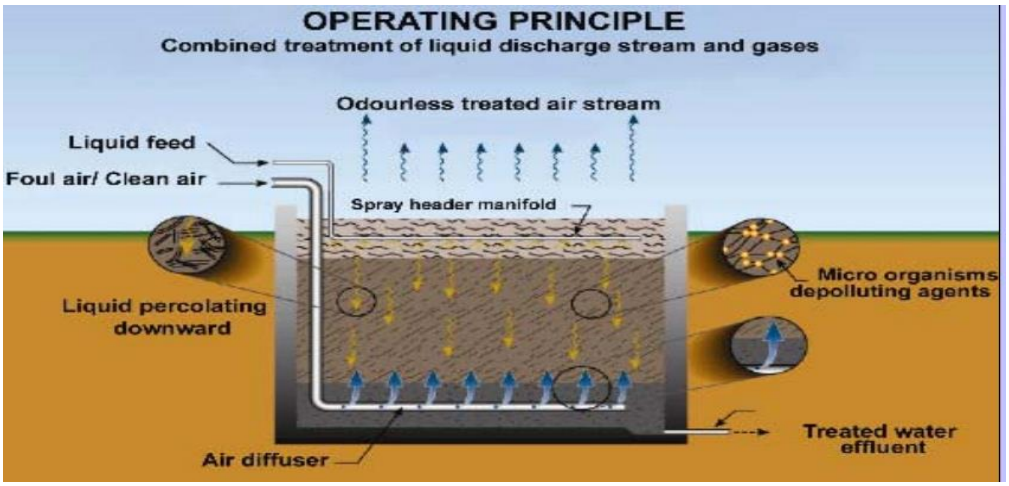

Figure 2: Biosor Operation

Such a process treats wastewater in a batch mode that is sequenced by series of treatment stages. The wastewater fills into tanks that specifically mix with biomass and settle. In addition, air is added to the tank to facilitate subsequent waste reduction. The sequence-based reactors have small footprint, flexibility, full back-up system, adaptable to retrofits, and no hydraulic (machinery) connection between incoming sewage and outfall.

UV Disinfection Wastewater Treatment

UV disinfection wastewater treatment can be another improvement for environmental sustainability of NWC. The NWC should adopt UV disinfection treatment for UV chemical chlorine disinfection as well as being cost-effective, eco-friendly and safe. The UV disinfection neutralizes microorganism that passes through ultraviolet lamps and submerged into the effluent. UV light is the best solution for wastewater treatment and UV disinfection helps to provide water resources to local water bodies and communities. In addition, the UV has been identified as an effective disinfectant specifically for chlorine-resistant protozoa such as Giardia and Cryptosporidium. Finally, the UV disinfection system observed bioassay validation testing that meets the environment's sustainability.

Integrated Wastewater Management System

The integrated sludge management system is a good approach to achieving efficient wastewater treatment. Integrating sludge management is NWC's need

because the sewage system is not working properly due to lack of collaboration and gaps in sustainable strategies. The sludge management system ensures sustainable reuse of sludge and the existing agriculture sector can implement this green and sustainable practices system. In addition to managing sludge for environmental use, the sludge management system integrates all phases of wastewater treatment. Sludge drying and use in landscape and agriculture is the most sustainable solution in this regard. Wastewater reuse can produce efficient results if the NWC ensures sludge reuse disposal options. The NWC will integrate all stages of wastewater treatment for better management. A proposed example of an integrated wastewater management system is shown in Figure 3.

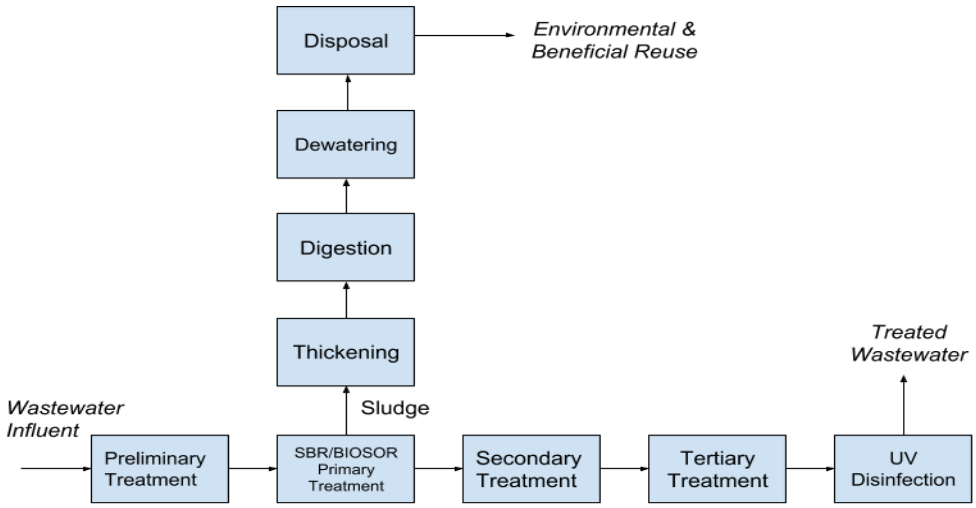

Figure 3: Integrated Wastewater Management System

Cloud Computing Information System

The role of an information system is important to maintain every record of wastewater treatment. The cloud computing information system could therefore be the best solution for environmental sustainability. All data will be stored on cloud computing and users can reach such a system and information for treating wastewater treatment. The information system identified as a non-functional requirement and the wastewater data stored and used during treatment. NWC currently has no cloud computing software for effective remote control and data management. After the clouding-based information system's implications, wastewater treatment will work in a short time frame and maximize water resources.

In Relation with Green BPM

All the solutions stated in the previous sub sections can be related to the management of green business processes. It is true that BPM optimizes resources and extends long-term business sustainability. The NWC should guarantee green BPM while implementing solutions. The role of an information system is important to maintain every record of wastewater. First

of all, functional requirements are important in this role because they identify relevant perspectives to effectively overcome issues. All of these solutions are cost-effective and have minimal environmental impact when considering wastewater treatment. The green BPM can be achieved by minimizing movement, remote monitoring and using existing assets. In addition, every improvement reduces environmental damage, increases water productivity, and helps sewage in a greenway. Green information practices are associated with the sustainable framework. The Green BPM Associated Elements represented in (Figure 4) green BPM and its associated elements for achieving sustainable wastewater treatment plan. First of all, business rules and management intervene in an efficient system of environmental practices. Second, monitoring business activity helps track each wastewater treatment process activity through preliminary, primary, secondary, tertiary bio filtration and sequence batch reactors. Furthermore, collaboration between employees and users optimizes output because the chances of error are reduced. Lastly, NWC also integrates enterprise integration with industrial wastewater suppliers and farming-related firms that want crops to be produced by water. Thus, integration between suppliers and producers can help achieve green BPM.

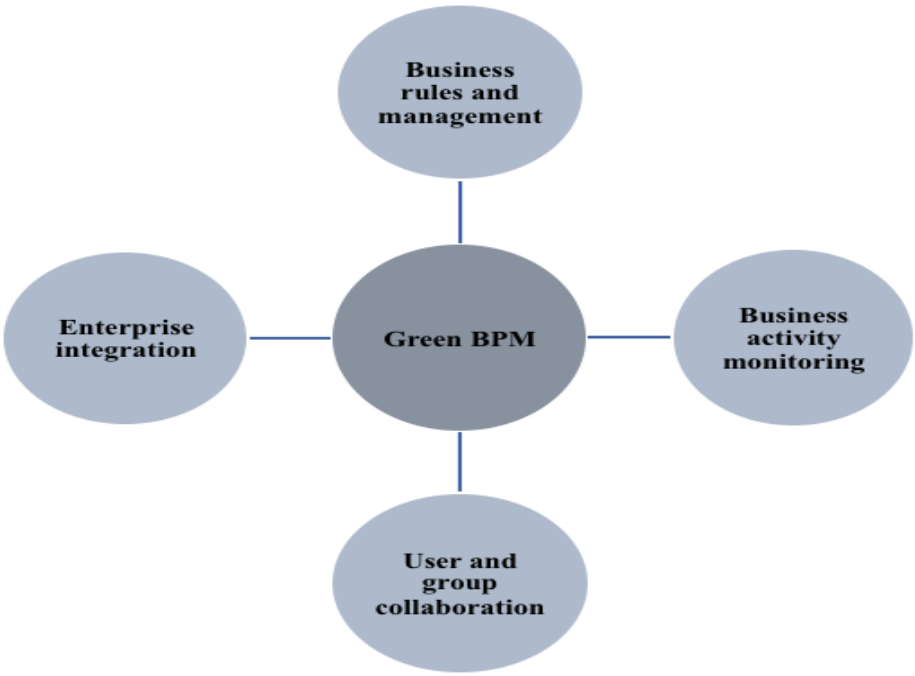

Figure 4: Green BPM Associated Elements

Security Requirements Measurements

The risk assessment of wastewater management can be handled by following mitigation strategies.

I. Identification of hazardous or toxic material in wastewater
II. Occupational health and safety measurement for workers
III. Personal protective equipment
IV. Training and development of staff who handles wastewater treatment

DEVELOPMENT OF FRAMEWORK

Framework

The main referral for creating the framework for improving sustainability in water management is UNICEF's [13] framework which focuses on programming for sustainability framework that were used to design and develop the proposed framework. Figure 5 shows the proposed urban sustainable water re-use service framework in this study.

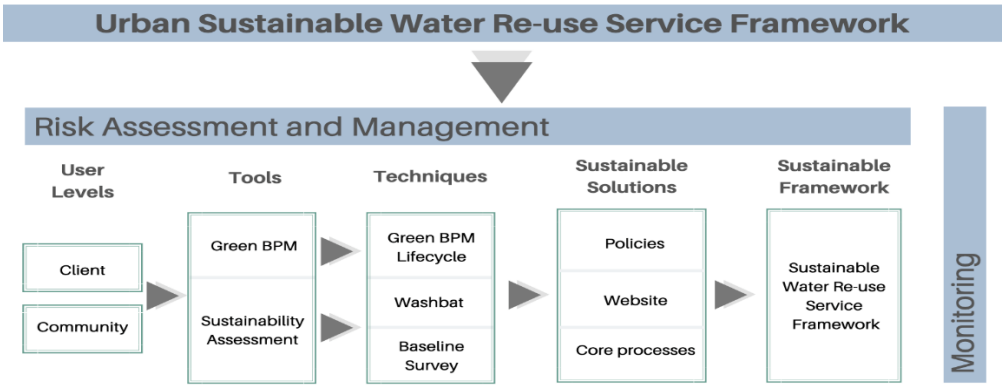

Figure 5: Proposed Urban Sustainable Water Re-Use Service Framework

The framework will be contributed and used by two (2) user-levels, based on the requirements from the company focusing on the group of people willing to be served with the proposed framework. These levels are client level and community level. A 'Client', in this case is NWC, means a corporate entity or organization if the contract is to provide a benefit social work service directly to the corporate entity or organization. Once the service is created, the customer must manage it well, taking into account the responsibility of the quality institution, it includes user service, provider and regulation (government). They also have contracts, service delegation, and payment taxes. In addition, the client will provide the community with the responsibility to access the service when receiving the required information from the community. Finally, the customer provides the service to the community by setting the service-related policies and regulations.

A 'Community' is a group of people forming a smaller social unit within a larger one, while sharing common interests, identity, and location. The community aims to help those who are developing a community of practice within government. Communities are the people that are final users of the service that interacts with the client. In this paper, the community is the people of Jeddah, Saudi Arabia. The community's needs, preferences and expectations are a key aspect of succession in providing the right service to the right people. This includes collecting information from the community itself for planning, pre-construction and construction of the service to achieve long and short-term sustainability.

Website

To further support the proposed framework, a proposed prototype website was made for customers to sell their services and for users (customers) to use those services with ease. The website contains components that are simple yet satisfying, such as an organization brief introducing their vision and mission. It also introduces the advantages of using treated waste water. Furthermore, to attain the treated waste water, an option for ordering tanks has been added. Last but not least, customer service option for any issues or concerns has been added as well. The prototype was created using Wix.com, a website that uses tools and many features to create professional websites. This prototype is intended to demonstrate the idea of using wastewater treatment services.
This website is believed to help customers use the service efficiently and effectively by achieving the sustainable framework. It will also help the customer easily reach the maximum number of customers in a short time. The website is composed of two sections, which are home section and order section. Figure 6 shows the home section of the website. Figure 7 shows the order section of the website.

Figure 6: Home Section of The Website

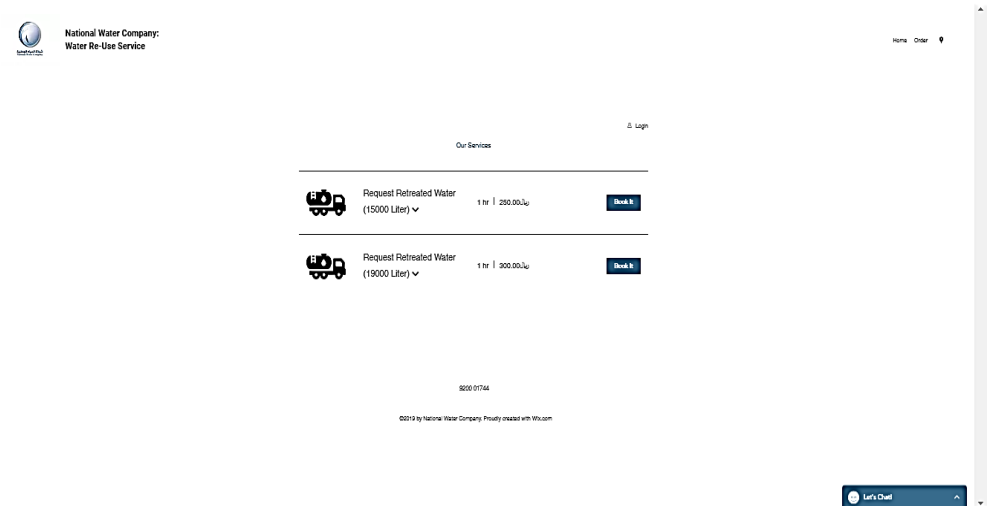

Figure 7: Order Section of The Website

Validation of Framework

According to López et al. [15], any problems solution must be evaluated to make sure it meets the requirements problem to solve it. To be able to evaluate it, validation is required to test the performance of the solution. Validation is the process of ensuring that an application can fulfill its expectations and ensuring the procedures and solutions are reliable [15].

The proposed urban sustainable water re-use service framework was validated and verified for its reliability, accuracy, efficiency and effectiveness by the industry experts and external experts belonging to NWC. It has been found that our proposed framework is acceptable to the experts, feasible and easy to understand. It also provides a comprehensive approach and a straightforward sustainability guide using Green BPM. In summary, the framework could be used as a basis for water reuse services to improve sustainability.

CONCLUSION

In conclusion, water wastage in Jeddah has been an overlooked issue for the past few years, especially when there is demand for water, population growth and climate change that may lead to water shortages in the future. In addition, wasted water also causes pollution in the Jeddah Red Sea, which is an environmental issue. This paper is a study to solve these problems by developing a comprehensive framework to benefit the environment, water companies and the population as a whole. Furthermore, sustainability, water treatment, water service processes, and green BPM were merged to develop the urban sustainable water re-use framework. This work has provided an approach for re-using water services and creating a sustainable framework that works towards vision 2030 of Saudi Arabia.

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