

## THE DETERMINANT FACTORS OF GREEN MAINTENANCE MANAGEMENT CAPABILITIES

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**Abstract.** The current maintenance management method has affected the efficiency and capabilities of the operation management. Many issues such as poor productivity and quality, inadequate finance, poor safety and morale, as well as environmental risks have emerged due to the current maintenance practice. In today's world, company is moving towards implementing green as an effort and attractive strategy to achieve sustainability and maintaining competitiveness in their business practice to cater the consumer demands. In this sense, green maintenance management capability (GMMC) permitting better company awareness and commitment to environmental sustainability while gaining effective maintenance practice. In this research, green technology and green human resource management were assessed, important issues were addressed and recommendation were made for prospect research.

**Keywords:** green management, maintenance management, preventive maintenance, corrective maintenance, human resources management.

### 1. INTRODUCTION

A highly valuable and expensive machinery are naturally technology expensive, rigorous and consistency critical needs continuous maintenance throughout their life cycle (Roy, Stark, Tracht, Takata, & Mori, 2016). Maintenance is a crucial in operation management activity, involving both services and goods. This research considering both technology and human resource management (HRM) element involve in green maintenance practice for both preventive and corrective maintenance. The green maintenance concept was introduced in the early 1990s with the objective of maintenance to be recognized via advances technologies and equipment at the minimum cost, least resources used and reduced waste, the least environmental impact and energy consumption (Jasiulewicz-Kaczmarek, 2014). The conceptual framework presented will guide operation team to carry out green maintenance practice through technology and HRM. This research proposed the following objectives:

- To introduce green human resource management in maintenance practice
- To introduce green technology in maintenance practice
- To promote Green Maintenance Management Capabilities

#### A. PROBLEM STATEMENT

Maintaining the production capability in any production system is an essential part of an operations management. An effective maintenance management is one of the strategy in operations management. For an example (Roy et al., 2016) mentions continuous maintenance technologies will improve capability to assess health of gears and products, develop independent maintenance explanations for efficiency and remote operation, visualize complex and uncertain data for decision making to reduce the risks and cost within an integrated maintenance planning environment. Apparently, there is no correlation between green elements in maintenance practice mentioned. Furthermore, according to Sheikhalishahi, M., Pintelon, L., & Azadeh, A. (2016) human factors should be taken into

account from the design phase of equipment and organizations because the important aspect of human factors in maintenance is maintainability, Green Production and Green Systems are a common process, but few literatures discussing on Green Maintenance (Ararsa, 2012). Hence, this research introduced the conceptual framework of Green Maintenance Management Capabilities (GMMC) by integrating green maintenance practice in technology and human resource management respectively.

## **2. LITERATURE REVIEW**

### **A. Technology**

The advances of technology have created exceptional stages of efficiency and extraordinary prospects for innovation in general, and technology-enabled value co-creation, (Roth and Menor, 2003; Chase and Apte, 2007; Breidbach and Maglio, 2016; Huang and Rust, 2018). Technology adoption consist of interaction among its component and can be manifest into four elements which are technoware, humanware, infoware and orgaware (Ramdhani, Aulawi, Ikhwana, & Mauluddin, 2017). According to Ramdhani et al. (2017), technoware element can be described as physical facility that used by human in operating and functioning a product changes which includes equipment, machinery, tool, physical infrastructure and motor vehicle. Humanware element can be described as human ability which includes human resource capabilities of individual or a group of people regarding their knowledge, expertise and skills, creativity, wisdom, achievement, experiences in utilizing available technology and natural resources. Infoware element can be described as information device that includes facts in document, including the procedures, manuals, methods, process, techniques, designs, theories specification and other facts disclosed via blueprint, document and publication. Orgaware element can be described as an organizational framework where it covers the organization regulations and device, the ability of human resources, required to contain technical and information device consisting of management practices, organizational setting and connection to gain positive result.

### **B. Green Technology**

Recently, the revolution in industry has created new awareness towards environmentally aware consumer. The green technology is acknowledged as the application of environmental science to conserve the natural environment and resources for the purpose of curbing the negative impact of human activities (Fauziah and Taib, 2015) and to keep the process of sustainable development by industry (Ramdhani et al., 2017). Example of green technology is cloud computing technology where virtualization concept being adopted and it gives tremendous support to computations, storages and communication (Kaur & Singh, 2013). The cloud computing has potential in leading towards overall energy saving and contribute into sustainable environment manner of green cloud (Kaur & Singh, 2013). Smart buildings, smart commerce, smart industrial production and smart services will lead to low carbon print in the environment preventing greenhouse effects while virtualization required lesser hardware hence it abides the energy wastage (Kaur & Singh, 2013).

### **C. Human Resource Management**

Human Resource Management is the process of recruiting, selecting, inducting employees, providing orientation, imparting training and development, appraising the performance of employees, deciding compensation and providing benefits, motivating employees, maintaining proper relations with employees and their trade unions, ensuring employees safety, welfare and health measures in compliance with labor laws of the land and finally following the Orders / Judgements of the concern High Court and Supreme Court, if any (Bratton J and Gold J, 2003). For the benefit of the individual, natural environment, society and business, Green Human Resource refers to the practices, policies and systems that make the employee of the organization green (Opatha & Arulrajah, 2014 p104).

#### D. Green Human Resource Management

Green Human Resource Management (GRHM) is generally promotes the causes of environmental sustainability by using the HRM policies that promotes the sustainable use of resources within organization (Marhatta & Adhikari, 2013, p.2). Green workforce that appreciates practices understands green initiative and maintains its green goals can be achieved throughout the process of training, recruiting, hiring, developing, compensating, and advancing the firms human capital (Mathapati, 2013, p.2). (Renwick, Redman, & Maguire, 2008) defined GRHM as the human resources dimension of environmental management system and the influence of employees on environmental performance outcomes within the frame of Ability-Motivation – Opportunity.

Proposed by (Khandekar & Sharma, 2005) the etiquette in which HRM can be greened is usually studied and observed in terms of a continuum exceeding all HRM practices – selection and recruitment of talent; rewards and compensation; appraisal and performance; development and training; organizational existence and employment relations. The researchers infer that green HRM practice should begin by recruiting ‘green’ talents and workers. Furthermore, HRM required proposing training and nurturing employees’ skills in environmental management. It is also recommended that HRM has a written key performance indicator for appraisals and also performance management systems. This will provide an easy platform for the HR managers to compensate and reward the ‘green’ workers. To make sure Green HRM practices is appreciated; the organization should provide mediums for the workers to present ‘green’ ideas, implement and participate in the associate initiatives such as encouraging Corporate Social Responsibilities (CSR) and greening workplace.

Green Human Resource Management (GHRM) has obtained its unique spot in the latest research in as much as the awareness regarding environmental management and sustainable development which gradationally grown. There have been countless deliberation about the issues of ethics, environmental degradation, social responsibility, marginalization, climate change and creation of strong voices of group protest on capitalism and radicalism (Urbancová & Hudáková, 2017).

#### E. Green Abilities in Operation Management.

Endlessly incorporate eco-friendly manufacturing is connected with environmental concerns where operation process applies green operation management (El-Kassar & Singh, 2019). Toward implementing green concept in organization, technology utilization helps in transforming traditional process to modern concept while getting supports from each level in management especially human resource department. Other explanation is green operation management considers source reduction or prevention, recycling and green product designs in operation cycle (Mishra & Siddiqui, 2014). To succeed in this goal, the management company should implement environmental management strategy to identify the key processes based on the department that has the potential to minimize waste of the company. Recovery and reuse policies, reduction of waste material and more sustainable alternative, incorporating new design “Eco-design” can also be implemented in the management.

#### F. Green abilities in an organization

The green abilities open up possibilities of performance improvement in the organization if being implemented efficiently and this were supported from Chithambaranathan, Subramanian, Gunasekaran, & Palaniappan, (2015) where the implementation of green programs would likely improve the overall environmental performance of the organization. This is the reason why the green paradigm has emerged as a philosophical and operational approach to reduce the negative ecological impact of organizations maintenance performance in real situation of the operation side. Improving the foundation of

environmental management, such as motivate personnel responsible for any environmental activity, upgrading environmental management systems, and effective environmental communication as well as conservation of biodiversity among employees is also part of the green abilities in organization.

#### G. Maintenance

Narayan (2012) stated that, the goal of maintenance management is to control the resources, time and costs of a company to ensure the efficiency and adequacy of the maintenance operations and to avoid waste of resources or periods of downtime due to faulty equipment. Maintenance management is one of those aspects of managing a company that is usually not explored in depth. People outside of the maintenance industry may not realize how much time and effort go into making the flow of products through supply chains to the general world. Let's go in-depth on these important processes and understand why they are important (Jasiulewicz-Kaczmarek, 2014). Maintenance nowadays has become a management issue with its function as a contributor toward profit whilst at the same time contributes to environmental and safety issues.

#### H. Preventive and Corrective Maintenance

Maintenance can be divided into two (2) main groups (Lind and Muyingo, 2012), which is corrective and preventive maintenance. Breakdown, failure-based, or run-to-failure, also known as corrective maintenance (CM), is the simplest type of classical maintenance policy (Mangano & de Marco, 2014). Preventive maintenance refers to regular, routine maintenance to help keep equipment up and running, preventing any unplanned downtime and expensive costs from unanticipated equipment failure. It requires careful planning and scheduling of maintenance on equipment before there is an actual problem as well as keeping accurate records of past inspections and servicing reports. Preventive management can be very complex, especially for companies with a lot of equipment. For this reason, many companies rely on preventive maintenance software to help organize and carry out all their preventive maintenance needs (Mangano & de Marco, 2014).

In order to keep down the operational cost while maintaining the service quality, both corrective and preventive maintenance is performed as planned and schedule basis (Saleh, Ibrahim & Abd Rahman, 2019). If the equipment is maintained only when it fails, it is called corrective maintenance (CM), while preplanned maintenance is called preventive maintenance (PM) (Savsar, 2013). Traditionally it is known that the probability of failure would increase as equipment is aged, and that it would sharply decrease after a planned preventive maintenance (PM) is implemented (Savsar, 2013).

Preventive maintenance involves the systematic inspection of equipment where potential problems are detected and corrected in order to prevent equipment failure before it happens. In practice, a preventive maintenance schedule may include things such as cleaning, lubrication, oil changes, adjustments, repairs, inspecting and replacing parts, and partial or complete overhauls that are regularly scheduled.

Preventive maintenance includes much more than simply performing routine maintenance on equipment. It also involves maintaining accurate records of every inspection and servicing, as well as knowing the lifespan of each part to understand the replacement frequency. These records can help maintenance technicians anticipate the appropriate time to change parts and can also help diagnose problems when they occur. Preventive maintenance software helps collect and organize this information so it is readily available to maintenance technicians (Costa & Balduino, 2018).

Corrective maintenance (also called breakdown maintenance) are maintenance tasks that are performed in order to rectify and repair faulty systems and equipment. The purpose of corrective maintenance is to restore broken down systems. Corrective maintenance is

initiated when an additional problem is discovered during a separate work order. For example, during an emergency repair, as part of a routine inspection, or in the process of conducting preventive maintenance, a technician spots another issue that needs corrected before other problems occur.

Upon discovering an additional problem, corrective maintenance is planned and scheduled for a future time. During the execution of corrective maintenance work, the asset is repaired, restored, or replaced (Costa & Balduino, 2018).

#### I. Green Maintenance

Energy efficiency is a cornerstone of green maintenance. Improving energy efficiency practices and sourcing renewable energy improves air quality and reduces the emissions of greenhouse gases that cause climate change. It also reduces ongoing operating costs by cutting utility bills. Strategies like continuous adjusting and commissioning of a building's energy consuming systems (e.g. lighting, heating, ventilation and air conditioning) will keep systems operating optimally. Replacing burned out components with the most recent energy efficient products is a cost effective way to increase a building's efficiency over time. Conventional building operations consume large amounts of resources, both in maintenance and in repairs/replacements. Selecting products that are durable, contain recycled content, or are designed for reuse/recycling helps reduce waste and conserves natural resources. Choosing water conserving faucets and fixtures saves money and reduces demand on limited water supplies (Zhang et al., 2012). It is also defined as making maintenance more environmentally benevolent by ensuring that maintenance has minimal negative environmental impacts while ensuring the protection, health and safety of maintenance personnel (Chew, Conejos, & Asmone, 2017). Olanrewaju (2011) describes green maintenance as the acceptance of a sustainable management approach in maintenance processes, methods and materials to minimize contamination that is financially sensible and encompasses social integration, thus ensuring an approach that meets the users' present value structure without compromising the capability to meet users' value structure in the future (Chew et al., 2017).

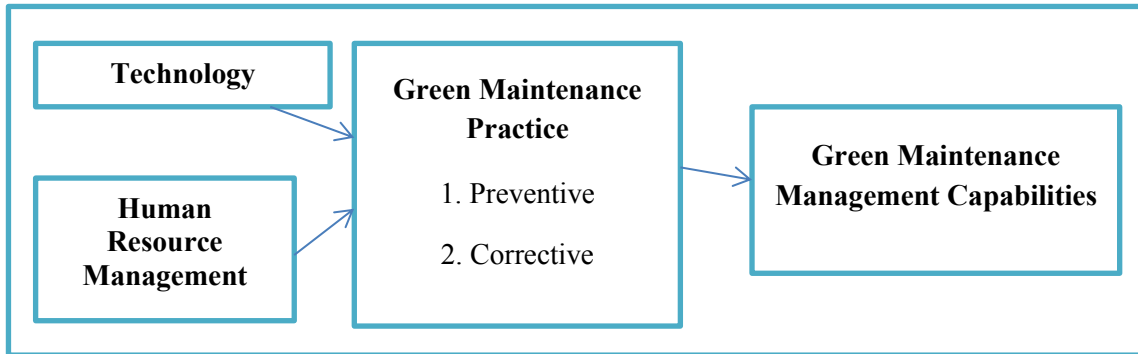
#### J. Green Maintenance Management

Green maintenance is management of maintenance operations in an environmentally friendly way. According to Killick and Thomas (2008), all maintenance activities need to be captured via a common system in order to ensure it can be planned and carried out on a consistent and sustainable basis to achieve its objectives (Too, 2012). Not only aim at the ecological growth object of lowest environmental contamination and highest efficiency of using resource for all start from maintenance to dumping as use loss, it also aim at the physical object of keeping and restoring the equipment to its given state (Jasiulewicz-Kaczmarek, 2014).

### 3. METHODOLOGY

The chosen method for the design of this paper consists of literature surveys from previous research paper or established journal to build the necessary theoretical background. Conclusion is to be drawn by analysis of the results gathered to develop the conceptual framework in this paper. The existing literature and case studies project of the technologies and HRM in green maintenance practice are reviewed subsequently to identify its integration result in green maintenance management capabilities (GMMC) conceptual framework.

#### 4. CONCEPTUAL FRAMEWORK



*Figure 1: Green Maintenance Management Capabilities Conceptual Framework*

The conceptual framework in figure 1 shows the technology and green maintenance practice (independent variable) with Green Maintenance Management Capabilities (dependent variable). The figure also shows the relationships between human resource management and green maintenance practice (independent variable) with Green Maintenance Management Capabilities (dependent variable).

Green maintenance practices contribute into green thinking organization that could benefit company's performance in terms of environment, productivity, quality, cost, safety and morale (Abd Ghani et. al, 2020). For instance, the outcome from productivity and quality resulted to reducing wasted energy from heating, cooling, and lighting during production downtime. Other than that green thinking can decrease the cost of environmental fees such as by waste segregation and decrease of amount of media use.

Meanwhile for environment, it can reduce the use of nonrenewable resources and improve product life cycle management. Safety and morale of green thinking will also reduce risks to the health of workers and increase of workers' consciousness for example by training programs conducted by HRM (Md Noor et al, 2020). Maintenance personnel must be trained with skills and knowledge of the current and latest technology used. These skills and knowledge are supported by efficient HRM which develops the correlation in green maintenance capabilities.

Nevertheless, the involvement of green abilities in HRM such as green recruitment, green selection, green induction, and green training and development is seen to support the application of technology in maintenance management that will contribute to the creation of green maintenance management capabilities.

For instance, in construction and development sector, through preventive maintenance point of view, a building design needs to be based on green concept such as green building whereas in the case of corrective maintenance, maintenance will be made without harming the environment by selecting green based material that could contribute to energy saving, zero waste and less pollution (Md Rasid, Ibrahim, & Shabudin, 2019).

#### 5. CONCLUSION

To ensure effective green maintenance management capabilities to be fully implemented, organizations must be proactive in searching for the best technologies contributing green maintenance practice. Moreover, the employer needs to ensure that their employees are well trained to conduct and utilize any new green technologies. Hence, the organization needs to invest more in creating awareness and implementation of the green abilities. As suggestion, further studies of this conceptual framework can be conducted in different industrial fields and cultures.

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