Factors Affecting the Maintenance Management Operations of a Leading Property Management Corporation: A Green IT Readiness Assessment Using Structural Equation Modeling

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Abstract

Increasing demand for environmentally sustainable development in different business industries has led to the application of Green IT across the world and resulted in a positive outcome. It is in this light that an answer can be sought interestingly to the question if the Green IT approach can be applicable for different corporations in the Philippines that aim for environmental sustainability business operations, particularly the maintenance management operations of a leading property management corporation. The capability of an organization to apply Green IT in its operations is measured by the relationships among Green IT Readiness dimensions, that were assessed using Structural Equation Modeling (SEM), regarding the multivariate causal relationship methodology developed by Daltoé et. al. (2013). The positive beta correlation to the factors was able to prove that Green IT could be applied in the Philippines particularly in a property management corporation. This showed that Green Technology, Green IT Practice, Green IT Governance and Policies, and Green IT Readiness are significant factors. Green Technology to Green IT Practice to Green IT Readiness would be the best causal relationship. Engagement in departmental training programs that would inspire employees to adopt environmentally friendly habits was recommended to prepare the employees in an environmentally-conscious business for the reason that, organizations that have a positive outlook on the environment and have mindfulness on sustainability are Green IT ready.

Keywords
Green IT, Environmental Sustainability, Green IT Readiness, Maintenance Management

1. Introduction

Delmas and Toffel (2004) stated in their study the need for industries to adapt to the demands of sustainability. Currently, different companies are looking for new ways and different strategies to gain competitive advantage since different industries are now leaning to sustainability. Moreover, people around the world have become more conscious regarding the environment. In the study of Molla (2008) he stated that more people have become vocal, voicing out their concerns regarding the environment, to different business operations of companies, who they observe have harmful effects on the environment.

Different industries have been turning their operations *green*. Green practices are becoming more relevant in the engineering and IT operations of companies and in the decisions of companies (Daly and Butler, 2009). Examples of these green practices are Green Manufacturing, Green Supply Chain Management, Green Chemistry, Green Accounting. The current era revolves around technology, hence green technology plays an important role in sustainable development goals. Green Technology plays a fundamental role in achieving the global and local sustainable development goals, which are to mitigate the negative consequences of the traditional economic development model and improve living standards (Ishak et. al., 2017; UNCTAD, 2018).

According to Fuchs (2008), Green Information Technology is increasingly becoming more connected to eco-sustainability as both a source and a solution. IT can be deployed to prevent pollution, improve product stewardship, and facilitate sustainable development (Melville et. al., 2010). However, since technology uses energy, consumption

of too much energy would be a form of waste and also a form of pollution and carbon footprint hence, green development must involve energy conservation as well. Green IT would lessen production of waste and it can also improve efficiency but everything has to balanced and regulated.

2. Background of the Research Problem

Green Information Technology (GIT) is an example of a green growth initiative designed to improve performance and productivity by consuming and producing organizational and social resources sustainability (Gazzola & Przychoden, 2018). Maintenance management is one of the examples of organizational activities that is critical if equipment performance is to be continuously improved, ensuring quality operation under safe conditions for people and the environment as well as being efficiently used to prevent the losses resulting from the breakdowns within a company (Jiang & Arslankaya, 2015). In order to achieve sustainable performance in maintenance management, proper handling of the resources must be observed and they must also be in accordance with the standards for the environment, health, and safety.

Companies utilize Computerized Maintenance Management System (CMMS), a computer database that centralizes maintenance information and facilitates the process of maintenance which includes scheduling, preventive maintenance, and repairs. Application of Green IT will make organizations achieve sustainable maintenance management operations.

3. Research Question

Green IT Readiness is the ability of the organization to *green* its IT or the application of environmental standards to its IT technical infrastructure and IT human and management practices through key IT development, acquisition, operations, and disposal areas, in order to reduce emissions, and improve energy efficiency (Molla et. al., 2014).

Bearing in mind of the mentioned Green IT applications and the positive results that an answer can be sought interestingly to the research question—**What Green IT approach can be adapted in the maintenance operations of property management firms?**

Corollary questions that the research want to be acknowledged are the following:

- What are the perceived effects of Green IT adoption to the maintenance operations of property management firms?
- Are property firms ready to adopt Green IT in their maintenance operations?
- What Green IT implementation platforms can be recommended as reference for crafting a sustainability maintenance strategy?

4. Objectives and Scope of the Research

The study's objectives are the following:

- To review the sustainability policies and practices of IT related activities of the maintenance operations in property management.
- To determine the significant drivers of and factors affecting Green IT implementation.
- To recommend a Green IT implementation platform in maintenance operations to improve the sustainability performance.

The study aims to assess the maintenance management operations of a Philippine-based property management company in view of developing a Green IT implementation platform consistent with its sustainability efforts. The significance of the research is not only limited to the organization being assessed but is presumed to be applicable also for different corporations in the Philippines that aspires for Green IT business operations.
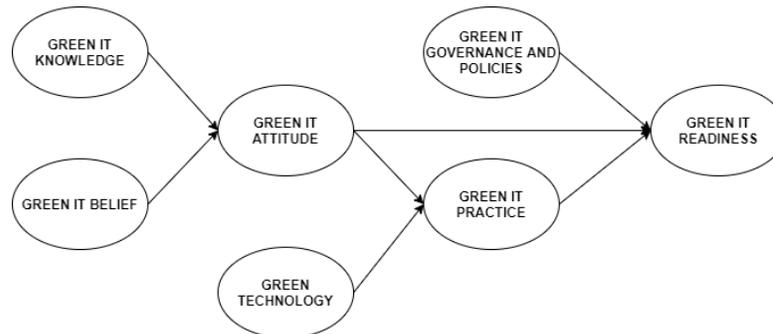
5. Methodology

Figure 1: Conceptual Framework

Considering the different factors from various related literatures, the framework above conveys the different factors that affect the Green IT Readiness of an organization. An individual's attitude greatly depends on its knowledge on Green IT. When a person has knowledge on Green IT, he already has assumptions on how Green IT works. These assumptions play a great role in influencing one's Attitude about Green IT, therefore showing their relationship with one another. On the basis of experience and education in green practices, individuals widen their awareness of the cause and the effect of environmental issues. Its relationship with Green IT Attitude relies on how deep an individual's belief on Green IT is. IT practitioners will add to the corporate initiative to reduce waste and energy usage by implementing personal green computing activities such as shutting off machines while not in operation. The mindset of workers towards green computing represents a dedication to accepting responsibility for the efficient usage of IT tools at work (Molla et al., 2011). Green IT Attitude factor has a direct relationship to the Green IT readiness of a company because it is a collective effort, from the company itself, as well as its workers and without this factor, a company would not be able to perform the role of being a Green IT ready company accordingly. The Green IT Governance and Policies have a direct effect on whether a company is Green IT ready. The role of the company in providing standards, rules and regulations, have a huge effect on how their employees will perform, therefore making this factor important in assessing Green IT readiness. Before a company can practice Green IT, having the right Green Technology will help them boost their progress towards becoming a Green IT ready company. This explains the relationship between the two factors. Green Technology has a direct relationship to Green IT Practice such that a company that has all the necessary Green Technology means that they have switched to technologies that will be used to mitigate or eliminate the effects of human activity in the environment. When a company has Green IT initiatives, the person involved in it will acquire various skills and knowledge that will soon affect how he/she does the job. Eventually, it will be acquired by the individual.

The Green IT Readiness dimension refers to the Green IT capability of an organization as demonstrated through a combination of different factors--Green IT Attitudes, Green IT Policy, Green IT Practice, Green Technology, Social Influence, Green IT Knowledge, Green IT Belief, and Green IT Governance and Policies to lessen IT, business process, and supply chain-related emissions, waste, and water use; improve energy efficiency, and generate Green economic rent (Lado et. al., 1992; Hart,1995; Dutta and Mia, 2010; Molla and Licker, 2005).

5.1. Hypotheses

From the Conceptual Framework, the following hypotheses were posited:

H1: *Green IT Knowledge has a significant direct effect on Green IT Attitude*
H2: *Green IT Belief has a significant direct effect on Green IT Attitude*
H3: *Green IT Attitude has a significant direct effect on Green IT Practice*
H4: *Green IT Attitude has a significant direct effect on Green IT Readiness*
H5: *Green IT Governance and Policies has a significant direct effect on Green IT Readiness*
H6: *Green Technology has a significant direct effect on Green IT Practice*
H7: *Green IT Practice has a significant direct effect on Green IT Readiness*

5.2. Data Collection

To review the sustainability policies and practices of IT related activities of the maintenance management operations of a Philippine-based property management corporation, the data were collected through an interview with the Technical Group in-charge of operations. The records and documents were utilized to review and check if the current sustainability policies and practices of the company is aligned with the standard for sustainability practices which will be vital in realizing if the company is Green IT ready.

The company records and documents were shared with permission to be used solely for academic purposes but due to confidentiality it was only allowed to be seen. These documents include published company circulars, posters and bulletin board records, and audit documents. The process review includes flowcharts and the walkthrough of their operations.

As the primary research instrument and to determine the significant factors in the implementation of Green IT, a survey which is a self-administered questionnaire developed from previous studies, were accomplished by the employees. Prior to the accomplishment of the Green IT Readiness Survey, a short refresher quiz regarding an overview of what Green IT is was accomplished by the respondents. By doing so, the respondents' profiles would precisely state if they already have an understanding and familiarity regarding Green IT and its effects on the environmental sustainability of a company. The respondents were those involved in the maintenance management operations of a leading Philippine-based property management corporation. There were a total of 675 employees from--Technical Group, HR Department, Finance, and other departments, all of whom were affiliated and have a duty in the maintenance management operations.

The study used Raosoft-sample size calculator, to calculate the recommended sample size, based on the population size of the company. The recommended sample size is 251. Respondent anonymity was assured to keep safe personal opinions from affecting their job and their reputation. The actual survey comprised seven parts based on the model in Figure 2 above, namely: Green IT Knowledge, Green IT Belief, Green IT Attitude, Green Technology, Green IT Governance and Policies, Green IT Practice, and Green IT Readiness. All items were measured using a five-point Likert-type scale, with responses ranging from strongly disagree to strongly agree regarding the major areas of analysis of the factors affecting the maintenance management operations of the leading property management corporation.

5.3. Structural Equation Modeling

Data analysis was made possible through Structural Equation Modeling (SEM) was employed to test the hypotheses using AMOS software. The study aims to test the hypotheses using p value of 0.05 to obtain results that show significant factors regarding Green IT readiness, and to determine the ideal causal relationships, and lastly, to verify the results of the model fit.

6. Results and Discussion

The first objective of the study was to review the sustainability policies and practices of IT related activities of the maintenance management operations of a Philippine-based property management corporation. This was possible through visitation, observation, documents review, and an interview with the Technical Group in-charge of operations. The maintenance management operations of the company were guided by the ISO 14001 series of documents, which provides companies with a set of standards that has been developed to help organizations meet their specifications for environmental management systems. The corporation's application of ISO 14001 fulfills two requirements; First, the internal need for a system that will help the corporation to tackle all the legal, commercial and other environmental problems it currently faces. Second, the need to be able to ensure that the organization complies with its specified environmental policies outside the organization.

MEASURE	ITEMS	N	%
Gender	Male	144	57.4
	Female	107	42.6
Age	26 and below	65	25.9
	27 - 33	118	47
	34 - 40	52	20.7
	41 and above	16	6.4
How long have you been working for the company?	less than 6 months	5	2
	6-11 months	16	6.4
	1-2 years	135	53.8
	3-5 years	73	29.1
	more than 5 years	22	8.8
Do you have a background knowledge on Green IT?	yes	247	98.4
	no	4	247
On a scale of 1-5, 5 being the highest, how concerned are you about environmental issues?	1	0	0
	2	0	0
	3	2	0.8
	4	38	15.1
	5	211	84.1
On a scale of 1-5, 5 being the highest, how aware are you with the negative impacts of IT operations in your company?	1	0	0
	2	0	0
	3	6	2.4
	4	94	37.5
	5	151	60.2
Were you trained to integrate green concepts into your work?	yes	248	98.8
	no	3	1.2

Figure 2: Respondents' Profile

Shown on Figure 2, is the results of the survey. 92% of the respondents have been working for the company for at least a year (thus knowledgeable at tasks), 98% have a background knowledge on Green Practices and Green IT, 84% place a high rating on the concern for environmental issues, 98% rated high on the awareness of environmental impacts of maintenance and IT, and 98% had previous orientation on sustainability and green concepts.

6.1. Results of Hypothesis Testing

1. Green IT Knowledge has a *minimal but* **significant** direct effect on Green IT Attitude.
2. Green IT Belief has a **significant** direct effect on Green IT Attitude.
3. Green IT Attitude has *no* significant direct effect on Green IT Practice.
4. Green IT Attitude has *no* significant direct effect on Green IT Readiness.
5. Green IT Governance and Policies has a *minimal but* **significant** direct effect on Green IT Readiness.
6. Green Technology has a **significant** direct effect on Green IT Practice
7. Green IT Practice has a **significant** direct effect on Green IT Readiness

6.2. Discussion of SEM Results

CAUSAL RELATIONSHIP			FACTOR LOADING SCORE
GIT BELIEF	→	GIT ATTITUDE	.53
GIT KNOWLEDGE	→	GIT ATTITUDE	.42
GIT ATTITUDE	→	GIT PRACTICE	.14
	→	GIT READINESS	.14
GREEN TECHNOLOGY	→	GIT PRACTICE	.83
GIT PRACTICE	→	GIT READINESS	.49
GIT GOVERNANCE AND POLICIES	→	GIT READINESS	.42

Figure 3: Summary of Causal Relationship and their Factor Loading Score

Shown on Figure 3, *Green IT Knowledge to Green IT Attitude* and *Green IT Belief to Green IT Attitude* are both significant yet they only stop until Green IT Attitude. This indicates that these factors are still beneficial and advantageous for the corporation's capacity to be Green IT ready.
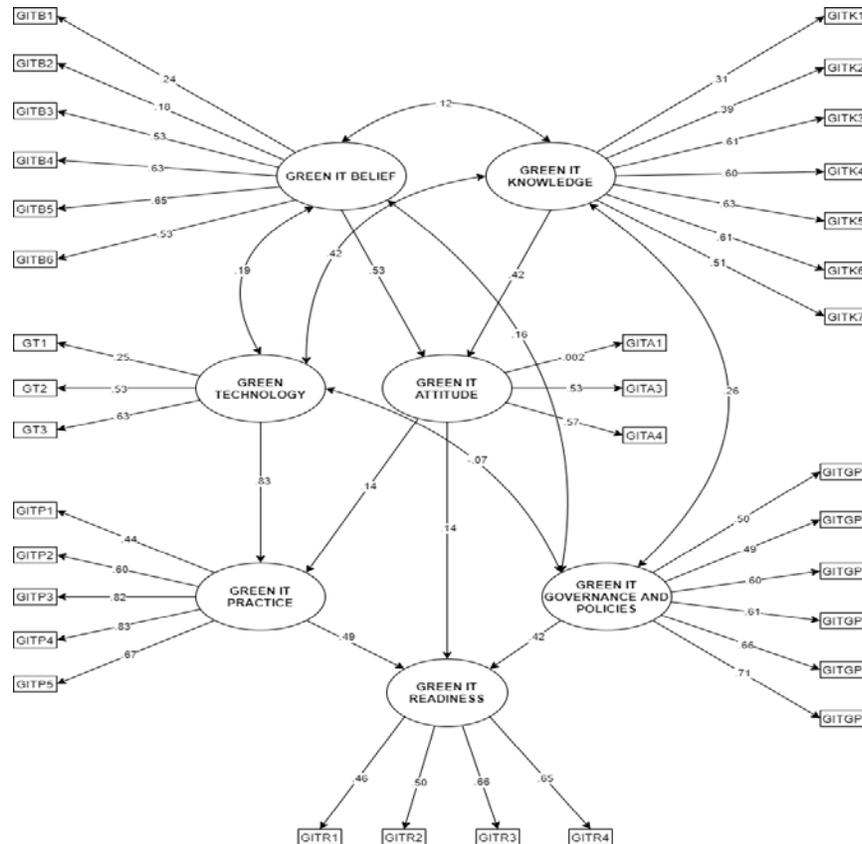

Figure 4: SEM Framework for the Evaluation of the Factors Affecting the Maintenance Management Operations of a Leading Property Management Corporation

Based on the results of SEM, four latents are significant: *Green Technology, Green IT Practice, Green IT Governance and Policies*, and *Green IT Readiness*. For the causal relationships, Green IT Knowledge to Green IT Attitude and Green IT Belief to Green IT Attitude are both significant. However, it stops only until Green IT Attitude because Green IT Attitude to Green IT Practice and Green IT Attitude to Green IT Readiness obtained a low score of 0.14 which is considered insignificant.

Table 3: The Model Fit--parameter estimates and goodness of fit

Goodness of fit measures of the SEM	Parameter estimates	Suggested cut-of
Goodness-of-fit index (GFI)	0.88	> 0.80
Adjusted Goodness of Fit Index (AGFI)	0.85	> 0.80
Root Mean Square Error of Approximation (RMSEA)	0.023	< 0.05
Incremental Fit Index (IFI)	0.914	> 0.90
Tucker Lewis Index (TLI)	0.90	> 0.90
Comparative Fit Index (CFI)	0.91	> 0.90

As presented in Table 3, The model fit of the SEM was evaluated by six measures; Goodness of Fit Index (GFI), Adjusted Goodness of Fit Index (AGFI), Root Mean Square Residual (RMR), Incremental Fit Index (IFI), Tucker Lewis Index (TLI), and Comparative Fit Index (CFI). According to Gefen et al. (2000), values that are greater than

0.80 for GFI, and AGFI is an indication of a good model fit. In addition to that, a value less than 0.05 is a good indication that the model is acceptable for RMR (Gefen et al., 2000). Lastly, a value greater than 0.90 for IFI, TLI, and CFI is also an indication of a good model fit (Maiyaki, et. al., 2010).

All the results satisfied the cutoff of the measures which means the model fit of the research is good.

No	Variables	Direct effect	P value	Indirect effect	P value	Total effect	P value
1	GITB -> GITA	0.530	0.001	-	-	0.530	0.001
2	GITB -> GITP	-	-	0.474	0.001	0.474	0.001
3	GITB -> GITR	-	-	0.802	0.001	0.802	0.001
4	GITK -> GITA	0.422	0.001	-	-	0.422	0.001
5	GITK -> GITP	-	-	0.179	0.001	0.179	0.001
5	GITK ->GITR	-	-	0.303	0.001	0.303	0.001
6	GITA -> GITR	0.139	0.001	-	-	0.139	0.001
7	GITA -> GITP	0.144	0.001	-	-	0.144	0.001
8	GT -> GITP	0.834	0.001	-	-	0.834	0.001
9	GT -> GITR	-	-	0.519	0.001	0.519	0.001
10	GITP -> GITR	0.491	0.001	-	-	0.491	0.001
11	GITGP -> GITR	0.42	0.001	-	-	0.42	0.001

Figure 5: Path Analysis

Shown on Figure 5, the best causal relationship is Green Technology to Green Practice and then to Green IT Readiness. The SEM proved that there is a positive relationship between Green Technology, Green IT Practice, and Green IT Readiness.

7. Conclusion

The research produced a good fitting model from the AMOS software using Structural Equation Modeling. Moreover, Green IT Attitude and Green IT Practice have significant relationships with Green IT Readiness. On the other hand, Green IT Governance and Policies only have a perceived minimal direct effect on Green IT Readiness.

Implementation of Green IT platform is inevitably recommended for similar businesses with intensive maintenance operations with the following conditions or elements:

- They must have clearer policies on Green IT as a key result area with desired results or outcomes in terms of stakeholder satisfaction financial performance, sustainability and company reputation.
- They must adopt a strategic initiative that will improve Green IT Governance and Policies with clear key performance indicators.
- They must standardize the business processes. Standardizing the operations will make the whole operations systematic, making it organized, sustainable, and easy to manage.
- The must create trainings for employees that promote green practices to reinforce Green IT Knowledge and Green IT Beliefs.
- They must install CMMS in order to integrate maintenance, inventory, and procurement. It is advisable to complement it with a CMMS Mobile Application for real-time information sharing and more responsive customer-driven service.
- They must drive continuous improvement via technology reviews, best practices, and reward system to incite productivity.

8. Recommendations for Future Research

A quantitative research can be conducted in the future to devise a Green IT Readiness Index based on the results of this study. Moreover, areas other than Maintenance Operations of a property management firm can be further considered with both organizational and stakeholder perspectives. Lastly, the resulting SEM model fit can be made a theoretical framework for future similar studies for other industries with intensive maintenance operations.

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