

Which Factors Drive Firms' Green Information Technology Practices?—an Integrated DEMATEL–ANP Approach

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Abstract. Scholars have identified various factors for adopting green IT by organizations from different perspectives. However, the studies about the priority of those factors and the interdependent relations among them are relatively lack. To address this problem, we use the Motivation-Opportunity-Ability (MOA) framework to establish a systematic model of the factors which drive firms' green IT practices. Furthermore, an integrated Decision-Making Trial and Evaluation Laboratory (DEMATEL) and Analytic Network Process (ANP) approach has been adopted to analyze the complex relations among different factors and determine the weight distribution of them. The results show that top managers supports, policy and regulation, institutional pressure and human resources are key factors driving firms' green IT practices. This study provides the implications for organizations and policy makers to understand and develop strategies to implement green IT.

1. Introduction

Information technology (IT) is the cornerstone for the development of modern society. The dependence of various industries on IT is rising [1]. But at the same time, the energy consumption, carbon dioxide emissions and increased e-waste brought about by IT cause great anxiety. Therefore, green energy conservation emerges as the main theme of IT development since it reduces the negative impact of IT on the environment [2]. Green IT is defined as “the research and practice of design, construction and use of hardware, software and information technology with a positive impact on the environment” [3]. The application of green IT not only brings benefits to enterprises but also plays an important role in supporting environmentally sustainable growth [4,5]. The term “Green IT” has become more and more popular and the number of related studies increases rapidly [6].

However, there are still several gaps between the research and practice of green IT [1]. As a young field, a unified comprehensive framework for green IT is lacked [3] which causes each firm has its own criteria about implementing green IT [5]. Furthermore, there are few studies focusing on the relations and the quantitative evaluation of those driving factors. Through addressing the question, our study contributes to green IT from two aspects. Theoretically, this paper develops the Motivation-Opportunity-Ability (MOA) framework to establish a new systematic model of the factors which drive green IT practices. Empirically, on the basis of the model, we analyze the relations among those factors and identify the key factors by using an integrated Decision-Making Trial and Evaluation Laboratory (DEMATEL) and Analytic Network Process (ANP) approach.

The remainder of the paper is divided into four sections. Section 2 establishes the systematic model based on literature review. Section 3 introduces the methodology, data collection and analysis procedure. Section 4 explains the relations among various factors and discusses the analysis results. In section 5, the conclusions and limitations of the article are presented.

2. Theoretical Framework

2.1 Related Work

Green IT can use IT resources in an energy-efficient and economical way [7]. The deteriorating environment and the concept of sustainable development have made green IT more and more widely

valued. Using green IT can support sustainable business operations and has a positive impact on the environment [8]. The organizational practices of green IT is complex which are influenced by external and internal drivers. For example, based on the institutional theory, coercive pressure, mimetic pressure and normative pressure are considered to be the main drivers of green IT practices [9]. Using the diffusion of innovation theory, researches present that the driving factors include champion support, regulatory, competition intensity and resource commitment, etc. [7]. From the stakeholder theory perspective, stakeholders' needs and pressures are determined as the key factors of green IT practices [10].

Although many researches have been made on the driving factors of green IT, there is insufficient research on the interaction and importance of each element. In order to find a way to overcome the challenges of green IT implementation, we need an appropriate theoretical framework which can incorporate environmental factors into different dimensions. Based on the framework, how the drivers of different dimensions jointly determine the green IT practices of enterprises can be analyzed. To address these issues, we present a Motivation–Opportunity–Ability (MOA) framework that provides a more comprehensive explanation of the firms' green IT practices.

2.2 The MOA Framework

The MOA framework is a relatively well-known theoretical framework for the study of organizational behavior, which is derived from the study of information reception behavior in the field of communication and marketing. The MOA framework consists of three core constructs: motivation, opportunity and ability. Ölander & Thøgerson first provide comprehensive analysis and interpretation of the relations among the three dimensions [11]. The interactions among them promotes the occurrence of specific behaviors. The model has the greatest degree of openness and inclusiveness, and it provides an effective framework for us to analyze the dynamics of behavior. Because it has good stability and predictability of behavior, the model is not only suitable for the interpretation of information receiving behavior, but also has a wide range of applications in the fields of public management, social capital, human resource management and knowledge management [12].

Table 1 The classification of driving factors

Dimensions	Factors	[1]	[4]	[5]	[7]	[10]	[12]	[14]	[15]	[16]	[17]	[18]	[19]	[20]	[21]
Motivation	Cognition of green IT			√	√							√			
	Corporate social responsibility	√					√				√				√
	Perceived revenue		√		√	√					√	√			√
	Institutional pressure		√		√	√	√		√	√	√		√	√	
	Top managers supports		√						√		√		√	√	
	Organizational strategy				√								√	√	
Opportunity	Policy and regulation	√	√		√	√		√	√	√		√		√	√
	Environmental awareness	√			√	√		√		√					√
	Market demand				√							√			√
	Mature green IT industry				√				√	√	√				
	Technical complexity	√				√			√		√		√		
	Technical compatibility	√									√		√		
Ability	Human resources			√			√	√							
	IT infrastructure			√			√	√			√				
	Investment ability								√					√	
	Corporate culture			√									√		
	Technical skills		√					√	√						
	Management ability			√						√	√			√	

This study uses the MOA model to analyze the driving factors of the firms' green ICT practice as well. Through literature research, we systematically summarize the driving factors of enterprise green IT practices and divide it into three dimensions of MOA. Motivation has a direct impact on green IT practices, while ability and opportunity mediate this process. This framework not only demonstrates the internal and external factors of green IT practices, but also reflects the relations among different factors. Table 1 shows the classification of all driving factors.

3. Methodology

Implementing green IT practices is a multiple attribute decision making (MADM) process. Many methods, including ANP, VIKOR and TOPSIS, etc., can deal with this type of problem. Among those methods, the DEMATEL-Based ANP (DANP) method has developed rapidly[22]. The DANP method is combined with Decision Making Trial and Evaluation Laboratory (DEMATEL) and Analysis Network Process (ANP). It can analyze the interactions among various factors and obtain the weight of each factor with relatively simple process. Therefore, the DANP method is widely used to address policy analysis, risk assessment and factors evaluation. And we also use the DANP method to determine the key driving factors of firms' green IT practices.

3.1 The DANP method

The application of the DANP method can be divided into two parts. First, we apply the DEMATEL method to analyze the relations and influence level of each element. Then, the results of DEMATEL can be used in the DANP method to obtain the weights of the factors[23, 24].

First part:

- (1) Obtain the direct influence matrix;
- (2) Normalize the direct influence matrix;
- (3) Generate the total influence matrix;
- (4) Building the network relation map;

Second part:

- (5) Normalize the total influence matrix;
- (6) Generate the unweighted super matrix;
- (7) Derive the weighted super matrix;
- (8) Obtain the weight of each factor.

3.2 Data Collection

The DANP method mainly uses the experience and knowledge of experts to address the problem. Therefore, the data in this article comes from 15 experts in the field of green IT. They use "0-4" to score the relations among the various factors and finish the questionnaire. The scale of 0-4 indicates the influence degree of "no", "very weak", "weak", "strong" and "very strong".

3.3 Data Analysis

According to the questionnaires, we apply DEMATEL method to get the direct influence matrix, the normalized direct influence matrix, the total influence matrix. Based on these results, the influencing and be influenced degree of each dimension and factor are calculated and the network relation map is built as shown in Fig. 1.

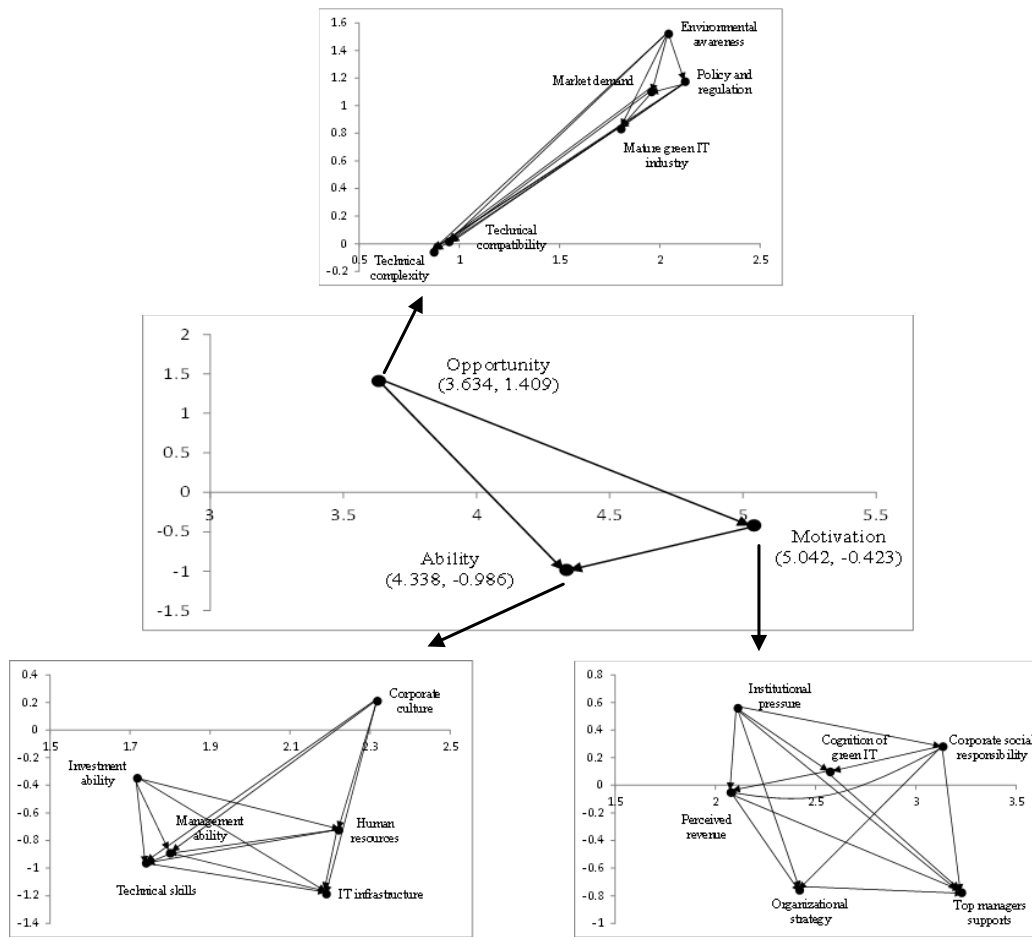


Fig.1 The network relation map

Based on the results of DEMATEL, we use DANP to get the weigh of each factor (as shown in table 2).

Table 2 The weights of dimensions and factors

Dimensions	Global weights	Criteria	Global weights
Motivation	0.4119	Cognition of green IT (m_1)	0.0607
		Corporate social responsibility (m_2)	0.0644
		Perceived revenue (m_3)	0.0285
		Institutional pressure (m_4)	0.0717
		Top managers supports (m_5)	0.117
		Organizational strategy (m_6)	0.0696
Opportunity	0.2696	Policy and regulation (o_1)	0.0865
		Environmental awareness (o_2)	0.0725
		Market demand (o_3)	0.0302
		Mature green IT industry (o_4)	0.015
		Technical complexity (o_5)	0.0136
		Technical compatibility (o_6)	0.0518
Ability	0.3184	Human resources (a_1)	0.0708
		IT infrastructure (a_2)	0.0518
		Investment ability (a_3)	0.054
		Corporate culture (a_4)	0.0682
		Technical skills (a_5)	0.0533
		Management ability (a_6)	0.0203

4. Discussions

This section will discuss the results of the DANP method. First, the weights of the three dimensions are 0.4119, 0.2696 and 0.3184. The results show that the starting point for firms' green IT practice is still its own motivation. However, the capabilities of the enterprise and the conditions provided by the outside are also indispensable.

In the motivation dimension, the highest weight is top managers supports (0.117). This shows that the top management of the enterprise needs to have sufficient cognition and attention to the green IT before it can promote the relevant practices. The second highest weight is institutional pressure (0.0717). That is to say, the pressure from society, suppliers and customers will encourage enterprises to actively carry out green IT practices. In the dimension of opportunity, the two most important elements are policy and regulation (0.0865) and environmental awareness (0.0725). Therefore, the government needs to develop policies on green environmental protection and a sound regulatory system. At the same time, as the public's awareness of environmental protection continues to strengthen, it also forces companies to use IT in a greener way. Human resources are the most important factor (0.0708) in the dimension of ability. All the activities of the enterprise are inseparable from human participation. The green IT practice has high requirements for technology and ability. Therefore, companies need to introduce talents and establish a dedicated team to ensure the smooth development of green IT practices.

5. Conclusions

This paper identifies relevant factors for green IT practices through a thorough literature review and is further confirmed by experts in the field. After that, these factors are classified by MOA framework. And the relations among different factors are studied by using DANP method to determine the weights of each factor. This paper not only systematically summarizes the factors of firms' green IT practices, but also expands the scope of the MOA framework. More importantly, the key factors can be identified more scientifically and effectively through the DANP method. The research results provide theoretical and practical support for enterprises to carry out green IT practices.

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