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## Proposed Model of Green Intellectual Capital in the Manufacturing Sector: A Developing Country Perspective

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### Abstract

In today's knowledge-based economy, the management of green intellectual resources (GIC) is very important in dealing with environmental issues. The implementation of GIC contributions is said to be able to help companies in driving competitiveness and sustainability. A green intellectual capital model is needed to enable companies that are sensitive to the environment, such as manufacturing companies in assessing the company's level of resource management. Since the existing GIC model is limited to measurement tools developed in developed countries, whose green technology progress is ahead of developing countries, a specific model that represents the perspective of developing countries should be developed. This paper is a continuation of the study on the measurement of GIC for environmentally sensitive companies in Malaysia. The methodology used in this study included a previous literature review, focus group interviews and expert reviews. The results of this study have classified GIC into 5 themes, namely green human capital (GHC), green innovation capital (GNC), green organizational capital (GOC) and green relationship capital (GRC). This model is also highly recommended for use by researchers and managers of the manufacturing sector in Malaysia and other developing countries.

**Keywords:** Green Intellectual Capital, Green Human Capital, Green Innovation Capital, Green Structural Capital and Green

### Introduction

The competitiveness and sustainability of companies in the knowledge-based economy era is influenced by the company's ability to deal with environmental challenges through the effective management of green intellectual capital (GIC). This is because the contribution of intellectual capital (IC) to add value is more than physical assets and financial assets (Bontis, 2001; Wasiluk, 2013). Early discussions and debates regarding the concept and development of the GIC model were pioneered by (Chen, 2008; Baharum & Pitt, 2009; Liu, 2010). Basically, the researchers summarized the meaning of GIC as intellectual capital about environmental

management. However, the GIC concept is divided into two main perspectives. Based on the first perspective, Chen (2008) defines GIC as "the total stock of all kinds of intangible assets, knowledge, capabilities and relationships about environmental protection or green innovation at the individual level and the organizational level in a company" (p. 277). The GIC model developed by Chen (2008) involves intellectual capital about green innovation. To date, most researchers have conducted studies on the relationship between GIC and competitive advantage and sustainability performance based on the measure developed by Chen (2008). However, this study argued that the model is not suitable for use in developing countries such as Malaysia because the model was developed in the context of developed countries, where the progress of green technology is ahead of developing countries.

The second perspective is highlighted by Liu (2010) who defines GIC as "the integration of green and environmental knowledge resources and company's know-how to improve competitive advantage" (p.2). This perspective looks at a broader concept of environmental management, rather than being limited to green innovation only. On the other hand, GIC is associated with knowledge sources related to any activity carried out by businesses to deal with environmental issues. In line with Liu (2010); Yahya et al (2014) proposed a measurement model for environmentally sensitive firms in Malaysia that views GIC as a source of knowledge used by companies to deal with environmental issues in conducting business activities. In the study, GIC has been classified into four subdimensions, namely green human capital, green innovation capital, green process capital and green social capital. This differs from other studies, classifying GIC into 3 dimensions only, namely green human capital, green structural capital and green relational capital. This paper is prepared to extend the study on the GIC model conducted by (Yahya et al., 2014). Consistent with Yahya et al (2014), this paper also classifies GIC measurement models into four dimensions due to the nature of activities carried out by the manufacturing sector in Malaysia that emphasizes on innovation capital.

The selection of the manufacturing sector in this study to address research issues because despite its huge contribution to economic growth, many pollution issues have been linked to the manufacturing process through their supply chain activities such as procurement, production and distribution (Eltayeb et al., 2011; Kuppusamy & Behrooz, 2015). According to Rozar, Mahmood, Ibrahim, & Razik (2015), manufacturing firms have been claimed to produce more emissions than other industries during production. In Malaysia, pollution problems are divided into four main causes, namely air pollution, oil spills and deforestation due to various types of regional development (Global Environmental Forum, 2000). According to Porter and Van der Linde (1995), such pollution is clear evidence of inefficient use of resources. In lieu of the need to address environmental issues by Malaysian manufacturing firms, effective and efficient GIC management is essential to ensure their competitive advantage. Therefore, the main objective of this study is:

- To develop an appropriate GIC model for Malaysian manufacturing firms

The GIC model will facilitate manufacturing firms to measure the level of investment and management of their GIC over time. Next, it will facilitate GIC researchers to conduct further studies on the relationship between GIC and company performance. and other factors. RBV is an important theory that explains the relationship between GIC and competitive advantage (Baharum and Pitt, 2009; Haldorai et al., 2022).The organization of this paper is divided as follows: part two discusses the summary of previous related literature, part three outlines the data and methodology used in this study. Section four presents the findings and section five is the conclusion of the entire paper.

## Literature Review

### Resource-Based View

A major contribution of the “A resource-based view of the firm” by Wernerfelt (1984) was his contention towards bundle of resources as important antecedents to products and ultimately to determine a firm’s competitive position (Priem & Butler, 2001). Barney (1991) described resources as bundles of tangible and intangible assets, which include all assets, capabilities, organizational process, firm attributes, information, knowledge, etc. controlled by a firm that enable the firm to conceive of and implement strategies that improve its efficiency and effectiveness” (p.101). RBV has widely been acknowledged for years as one of prominent theories used for describing, explaining, and predicting organisational relationships (Barney et al., 2011). Prior studies examining the relationship between manufacturing resources such as a set of process and unique equipment (Singh & Mahmood, 2014), organisational resources, capabilities and systems (Ismail, Rose, Uli & Abdullah, 2012) with firms’ performance or competitive advantage in manufacturing industry.

Barney (1991) suggests that sustainable competitive advantage could only be achieved if resources possess certain characteristics that are valuable, rare, imperfectly imitable and difficult to substitute. Several prior studies highlight that the intellectual capital is the main resource possessed by many organisations (Riahi-Belkaoui, 2003; Tseng & Goo, 2005; Hatch & Dyer, 2004; Padgett & Galan, 2010; Kamaluddin & Rahman, 2009; Cheng et al., 2010), having unique criteria of valuable, rare inimitable and non-substitutable resources that enable the firm to increase its competitive strategy. The RBV was also widely used to explain about whether the investment in green resources has significant positive effects on firms’ competitive advantage (Liu, 2010; Chuang & Huang, 2015; Lopez-Gamero et al., 2009; Dao et al., 2011).

### Green Intellectual Capital

GIC has been acknowledged as sustainable intellectual capital (Claver-Cortes et al., 2007), environmental knowledge sources (Liu, 2010) and intellectual capital about environmental management (Chen, 2008; Baharum & Pitt, 2009; Chaudry et al., 2016). GIC is an embryonic management practice that integrates the environmental management and IC disciplines. Environmental management concerns about how organizations care about the natural environment and minimize the negative environmental effects of their entire operations (Klassen & McLaughlin, 1996; Welford, 2000; Rio-Rama et al., 2018). But from other perspective, environmental management refers to innovation in technologies related to the green products and processes, such as energy-saving, pollution prevention, waste recycling, green product designs, and corporate environmental management (Chen, Lai & Wen, 2006; De Marchi, 2012). This perspective is adopted by Chen (2008) in building the concept of GIC.

Meanwhile, the IC scholars (Edvinsson and Malone, 1997; Stewart, 1997; Youndt, Subramaniam and Snell, 2004) define IC as accumulation of knowledge, which is created by firm’s employees, embedded in infrastructures and processes and its social networks within and outside the organization that enables company to function and create wealth. The accounting-based defines IC as the difference between the value of its tangibles net assets and its market capitalization (Lev, 2001). The market perspectives define IC as the differences between the book value and market value where the knowledge becomes the main factor in the generation of wealth (Edvinsson & Malone, 1997; Stewart, 1997; Lopez et al., 2010). Johnson (2002) contended that the basis for all intellectual capital components are

knowledge sets, or ideas. In other words, knowledge is the key to building IC (Hamdan & Damirchi, 2011). Most of the management and measurement of intellectual capital studies classified the IC into three types: human capital, structural capital and relational capital (Johnson, 1999; Bontis, 1999; Petty & Guthrie, 2000; Juma, 2005; Kamaluddin, 2009). However, Buren (1999); Wang & Chang (2005); Tseng & Goo (2005) classified IC into four types, namely human capital, innovation capital, organizational capital and relational capital.

Most GIC studies (Chang and Chen, 2012; Huang and Kung, 2011; Chen and Chang, 2013; Omar et al., 2018) adapt the model built by Chen (2008) which classifies GIC into GHC, GSC and GRC. Based on questionnaire surveys, these studies found that all the three dimensions were practiced in the organization. Liu (2010) measured GIC based on content analysis and was analysed using a multi-criteria decision-making approach called the analytic hierarchical process (AHP). Lopez-Gamero et al (2011) developed a sustainable IC model by conducting multiple case studies with Spanish firms to examine how sustainable IC helps to overcome the shortcomings of conventional approaches to environmental management systems. Baharum and Pitt (2009) built Facilities Management capital framework based on the resource-based view, that emphasizes the significance of green strategy in its knowledge components in achieving overall sustainability and profitability to an organization.

### **Green Human Capital (GHC)**

Human Capital represents human factors in an organization which include combined intelligence, skills and expertise that enable learning, changing, innovating and providing the creative thrust that give the organization its distinctive character. Human Capital possesses tacit knowledge that holds the innovation and intuition that must be verbalized (Egbu, 2004; Saint-Onge, 1996). The concept of green human capital (GHC) consists of cumulative tacit knowledge in human's mind relating to environmental protection (Liu, 2010). Boiral (2002) suggested that harnessing tacit knowledge associated with an environmental concern is particularly useful in three key areas of an environmental management; identification of pollution sources, management of emergency situations and development of preventive solutions.

### **Green Innovation Capital (GNC)**

Innovation capital can be depicted as the ability of an organization to generate new knowledge, develop new products, and the creative ideas based on previous knowledge (Tseng & Goo, 2005). It is also depicted as know-how, patents, trademarks and protected assets (Brooking, 1996; Roos et al., 1997; Stewart, 1997; Bontis, 1998). Innovation Capital is a measure of a company's ability to create new products which meet customer's demands, and design more efficient operating processes (Cheng et al., 2010). Thus, green innovation capital (GNC) also relates to firm's innovativeness, which reflects the ability of firm to respond to environmental changes in a speedy and flexible manner (Fraj et al., 2015). The environmental R&D is more intense in manufacturing industries (Padgett & Galan, 2010). R&D capabilities speed up the expansion of existing technologies and R&D function which emphasizes on generating innovative green products, number of patents, R&D intensity, the percentage of researchers to overall employees, and degree of innovativeness of R&D green products (Tseng & Goo, 2005).

**Green Organisational Capital (GOC)**

Organisational capital relates to the task of illuminating the institutionalized knowledge, routines, manuals, processes, or systems that an organization owns (Subramaniam & Youndt, 2005; Youndt & Snell, 2004). Organisational capital is composed not only the knowledge created by and stored in a firm's information technology system, such as structure and operating procedures, but also in intangible elements like cultural and informal routines. In the context of GOC, it can be viewed as manuals, practices, routines, process and procedures (systems) and generate knowledge about addressing the environmental issues effectively. The institutionalized knowledge and codified experience associated with environmental management requires rigorous documentation that contributes to the dissemination and retention of environmental knowledge within companies, which present in the codified environmental management systems (EMS) such as ISO 14001 (Boiral, 2002).

**Green Relational Capital (GRC)**

Relational capital can be defined as knowledge derives from interpersonal interactions, including internal and external relationships of an organization (Subramniam & Youndt, 2005; Youndt & Snell, 2004). Relational capital is related to knowledge needed to provide with ongoing value added relations especially with the economic agents who participate in different phases from the value chain of the product such as customers, suppliers, competitors and societal stakeholders. In terms of green relational capital (GRC), Chang and Chen (2012) asserted that it is important for companies or retain close relationships pertaining to mutual environmental interests with their external institutions and stakeholders. Chen (2008) defines GRC as "stock of a company's interactive relationships with customers, suppliers, network members, and partners about environmental management and green innovation, which enables it to create fortunes and obtain competitive advantages.

**Research Methods**

The GIC model for the manufacturing sector involved generating the relevant indicators based on previous literatures, focus group focus group interviews and expert reviews. In this study, the focus group interviews involve two group sessions. In the first group session, the initial invitations were posted via email on selected environmental managers, production engineers and general managers from manufacturing sector. Their details were taken from company's website and the website of Department of Environment, Malaysia. In total, 20 e-mail invitations were sent out to potential participants. Within the e-mail, potential participants were briefed about the purpose of the focus group study, the procedures and area of discussions to be discussed. However, only four respondents returned their consent form as an indication of their willingness to participate in the focus group interviews. An appointment was set up to meet the respective participant, but only 3 participants turned up.

In the second group session, five potential participants were invited to participate in the focus group interview during conference and exhibition held in Sime Darby Convention Centre, Kuala Lumpur. The potential participants were briefed about the purpose of the focus group study, the procedures and area of discussions to be discussed. However, only three (3) potential participants accepted the invitation. The discussion was conducted on the next day at the same venue, after the invitation was accepted. The focus group participants, (six of them) in both sessions, were holding the executives, production engineer, environmental manager, and business development manager working in manufacturing firms. The participants have working experience from three (3) to twenty (25) years. They were enquired

on their understanding on the definition and related examples of intellectual capital, environmental management, green intellectual capital, and proactive environmental strategy activities and also their understanding on how their firms are greater in terms of performance as compared to their competitors. The focus group was also utilised to assess the appropriateness of preliminary items in the context of Malaysian manufacturing setting that have been generated by researcher.

Considering the preliminary items and input gathered from focus group interview, a draft of questionnaire instrument was developed. At this stage, the wording of each measurement items are modified to fit the context of green intellectual capital, environmental strategy and competitive advantage within Malaysian manufacturing firms. In the process of seeking expert opinion, the draft of the questionnaire was presented to three experts of manufacturing firms and five academicians of local public universities. The experts were asked to comment on various aspects of the survey design such as the clarity or ambiguity of definitions, item representativeness, appropriateness of the scale, clarity of instructions, identify items that could be added or deleted from the instruments, and to make suggestions for enhancements. This process led in further purification of the items and resulted in a revised draft instrument and rewording of items to be appropriate to the target population. Consultation with the experts also helped to improve the structure and the content of the questionnaire.

### **Results and Discussion**

Based on previous literatures and expert reviews, this study defines GIC as knowledge resources utilised by company to address the environmental issues in conducting business activities to achieve firms' competitive advantage. GIC in the current study consists of GHC, GNC, GOC and GRC. The classification of the GIC into four dimensions, is based on the classification of GIC established by (Yahya et al., 2014). The measurement of each item in each dimension is classified into few themes or sub-dimensions. The themes have been identified based on IC measurement items and themes in previous IC researches, modifications on IC items and environmental management activities of environmental management literatures and opinion and comment from expert reviewers and respondents in pre-testing stage. The GHC in this study is defined as knowledge, skills and awareness to address the environmental issues possessed by individuals, shared and communicated throughout the organisation.

This study classifies GHC into five themes namely environmental capabilities, environmental learning and training, employees' satisfaction, environmental leadership and green teamwork. GNC is defined as the ability of a company to generate new knowledge, new product and any creative ideas aimed at addressing the environmental issues. It is classified into three categories, namely green research and development (R&D), green intellectual property rights (IPRs) and sustainability. The GOC is defined as the management of knowledge in addressing the issues effectively, that support employees' productivity. This study classified GOC into three themes namely processes and practices, green culture and green integration and coordination of knowledge. GRC in the current study is defined as knowledge that is embedded in relationships and networking with relevant parties to address the environmental issues. It is classified into three categories, namely customer relationship, supplier relationship and other stakeholder integration.

### **Conclusion**

This study proposes a GIC model in the Malaysian manufacturing sector. The methodology used in this study included a review of previous literature, focus group interviews and expert

reviews. This study suggests that in manufacturing firms, GIC should consist of four dimensions: GHC, GNC, GOC and GRC. In the development phase, GHC was classified into five themes: “environmental capabilities”, “environment training and learning”, “employees’ satisfaction”, “environmental leadership” and “green teamwork”. GNC was classified into 3 themes namely: “green R&D”, “green IPR’s” and “sustainability”. Similarly, the development of GOC suggest three themes: “green process and practices”, green culture” and “green integration and coordination”, whilst GRC represented by three themes namely “customer relationship”, “supplier relationship” and “stakeholder integration”. Overall, this study contributes to the existing literature by detailed out the four constructs of GIC into their specific themes for manufacturing firms in Malaysia and other developing countries. Future research should highlight detailed indicators of the themes.

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