

# Dynamic Eco Innovation Practices: A Systematic Review of State of the Art and Future Direction for Eco Innovation Study

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Received: August 17, 2014 Accepted: September 28, 2014 Online Published: December 2, 2014

doi:10.5539/ass.v11n1p8

URL: <http://dx.doi.org/10.5539/ass.v11n1p8>

## Abstract

**Purpose:** The purpose of this paper is to discuss the role of dynamic eco innovation practice in order to achieve sustainability in manufacturing industries. The outcomes of this paper attempts to describe core categories of eco innovation practices in manufacturing industry, drivers of eco innovation-practices and framework of dynamic eco-innovation practices. At the end of the paper provides insight of new research direction for eco innovation research in new millennium particularly in developing countries.

**Design/methodology/Approach:** The selected papers that have been reviewed were retrieved from Google scholar database with high citation index. A list of items/variables was developed for eco innovation measures based on dynamic capabilities theory pillar in eco innovation /green manufacturing through systematic literature review.

**Findings:** Manufacturing acknowledges technical target in form of both product and process eco innovation as a pivotal role to attain sustainability development in ecology, economy and society. There are four eco innovation drivers captured in literature namely regulatory push, technology push, market pull, and firm strategies. However, underlined dynamic capabilities theory, four measurements uncovered consists of technology collaboration, green human resource, eco innovation culture and environmental management system strategy. Exploring the factors of eco innovation effort considered as the heart of new research direction in new millennium.

**Originality/value:** Eco innovation is a new research area and limited knowledge established under micro level. Thus, this paper attempts to provide a clear direction of dynamic eco innovation practices towards eco innovation efforts in manufacturing industry en route for building the sustainable development echoes to economy, ecology and society.

**Keywords:** eco innovation, dynamic eco innovation practice, sustainability development

## 1. Introduction

Eco innovation terminology refers as an ecological, environmental, green and sustainable innovation that was initiated in most previous publications (Angelo, Jabbour, & Galina, 2012; Schiederig, Tietze, & Herstatt, 2012) and the terms have resemblance in the objective to reduce the environmental impacts (Schiederig et al., 2012). Eco innovation approved as a driver to achieve sustainability (Angelo et al., 2012; Carrillo-Hermosilla, del Río, & Könnölä, 2010) specifically in manufacturing industries (Sezen & Çankaya, 2013). Most manufacturers believed that by implementing environmental activities, effect on the company profit as incur in cost of operation in waste treatment and management. The growing attention of global concerned on sustainability and green practices acquire attention of both institutes and academic to discover the phenomenon. Furthermore, academicians and managers are keen to learn “how companies performing environmental innovation into manufacturing process and developing eco product” as limited knowledge and empirical study found in literature regarding on capabilities needed to manage green innovation at micro level specifically in developing countries (Carrillo-Hermosilla et al., 2010; Dangelico & Pujari, 2010; Hellström, 2007; Schiederig et al., 2012). Thus, this paper provides a meaningful review to clarify several questions listed as below:

- a) What are the core categories of eco innovation practices in manufacturing industry?
- b) What are the main drivers of eco innovation practices discussed in literature?

- c) What are the items underpinning in dynamic eco innovation practices?
- d) What is the insight of new direction for eco innovation research in new millennium particularly in developing countries?

**2. The Core Categories of Eco Innovation Practices in Manufacturing Industry**

As reported in the Manufacturing (2009) eco-innovation practices outline its target or object (products, processes, marketing methods, organisational and institutions) which contrary in report by (Rennings, 2000), eco target includes product, process, organizational, social and institutional. Meanwhile Arundel & Kemp (2009) defines eco target falls as the four categories such as an environmental technologies, organizational innovation, product and service innovation and green system innovation. Broad definition of eco innovation can be found in Carrillo-Hermosilla et al., (2010), yet, eco innovation definition in OECD manual is a pertinent to organization as useful guidelines (Arundel & Kemp, 2009), because the innovation definition acceptance worldwide and the information ahead compared to others institution. The Organization for Economic Cooperation and Development (OECD) report in eco innovation in industry promoted that eco innovation typology rest on *target*; technical (product and process) and non-technical (marketing, organizational and institution) innovation, *mechanism* or methods of changes (modification, redesign, alternatives and creation); and level of *environmental impact* (product life cycle).

As describe in the figure 1, there are five types of eco innovation which is predominant for sustainable development as explain in book entitled “Eco innovation in industry: enabling green growth” published by OECD (Machiba, 2009). According to (Hellström, 2007; Rennings, 2000), both product and process declared as one entity underlines technological changes which is comprises of integrated environmental technology to generate product and process changes that less harmful to environment (Arundel & Kemp, 2009; Y.-S. Chen, Lai, & Wen, 2006). Meanwhile, in the another hand, marketing, organization and institutions rest on the non-technological changes as the improvement relies on the management involvement (C. C. Cheng & Shiu, 2012) and cultural transformation (Rennings, 2000). However, at the heart of manufacturing areas, eco innovation under technological changes is predominant relative to non-technological changes because of major impact towards environmental performance. Manufacturing activities play a major contributor for environmental pollution from the process of taking natural resources, making a product and producing waste and emission contributed on the 61% of world energy consumption and 36% of global C02 emission respectively (Hart, Ahuja, & Arbor, 1996; OECD, 2009, 2012). Thus, as a way to support ‘the ability of current generation to meet their needs without compromising the ability of future generations to meet theirs’ (WCED, 1987), the manufacturing activities in new millennium are emphasized to implement technological innovation as part of the approach to show their responsibility towards sustainable development.

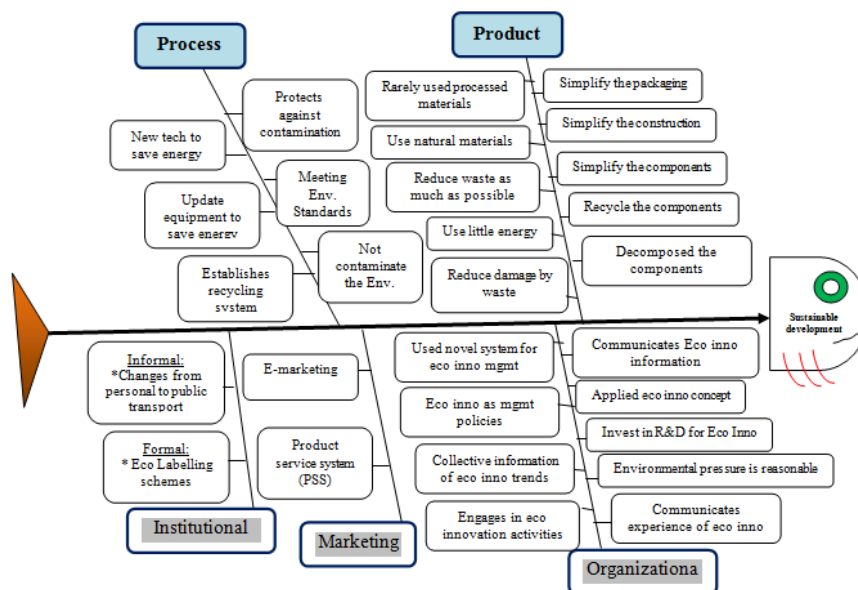


Figure 1. Eco innovations: The backbone of sustainable development

### 3. Main Drivers of Eco Innovation Practices Discussed in Literature

There is a rich stream of literature which describing several theories that is critical to drive eco innovation efforts by the organization namely stakeholder theory, resource base theory and institutional theory. According to Butler (2004), there are two theory that are prominent for eco innovation efforts at firm level namely; stakeholder theory, and resource based view theory where both theory emphasis on the firm eco initiatives are depending either on the stakeholders demands which is consist of its management, government regulations, consumers and environmental activist or base on the firms internal resource and capabilities. Meanwhile, for the Institutional theory rest on company's commitment towards environmental solutions resulted from tight regulation by government, professional associations, public opinion, or the media policy and compliances (Colwell & Joshi, 2013). Thus, the need of further study that applying these theories is critical to support the sustainable development in global forum. Furthermore, Halila (2007) in his dissertation provide a gap for the future understandings lies on the organizational level such as Institutional theory and resource based view theory. Hence, theory testing is important to gain more knowledge on which factors is crucial for organization to commit on eco innovation efforts.

As part of the theory establishment to describe the eco innovation initiatives, several authors pursuing on conceptual model to describe the critical factors for eco innovation. There are steady stream factors that profiling eco innovation efforts or green practice among the manufacturing industry as postulate by scholars. One of the well-known model has been proposed by Rennings (2000) in his article named "*Redefining innovation-eco-innovation research and the contribution from ecological economics*" which is describing the determinants of the eco innovation relies on the three main factors such as regulatory push, technology push and market pull. In the sequence of Rennings (2000) proposal, leading to the generation of the framework by (Horbach, Rammer, & Rennings, 2012) that extending the initial model by shed light firm strategies as piece of the puzzle to eco innovate. The framework of eco innovation determinants describe as per figure 2. Besides a series of model generation and empirical evidence proposed by Klaus Renning's and his colleagues, there are another model anticipated by the OECD which is called "Supply-demand model" that has been describing in (Machiba, 2009). Supply side initiatives rest on the government programs to encourage eco innovation exploration through funding the eco project, encourage R&D, education and training, creating a network and partnership. Meanwhile, at the demand side relies at the adoption and diffusion stages to the business activities, where government role on emphasizing the regulation of producing green product and increases the customer awareness to purchase eco product labelling scheme.

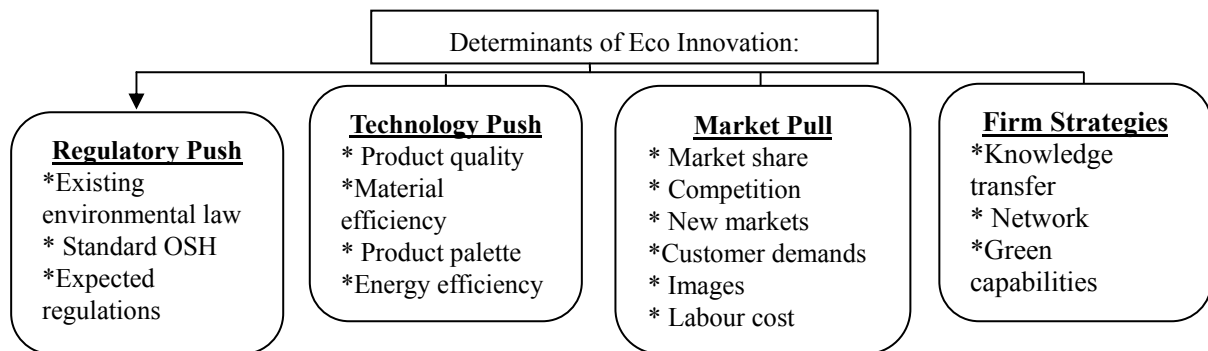


Figure 2. The determinants of eco innovation adapted from (Rennings, 2000) and (Horbach et al., 2012).

The aforementioned findings form theory establishment and model development drawing a similar conclusion that bridged the strategic weapons of environmental protection. In line with the literature assessment, both of them are keen to discuss the antecedents of the firms eco initiatives can be either external factors or internal factors. At the heart of the external factors, the indicator consist of regulatory push from the government, market factors in terms of meeting customer requirement, and technology competition. In another dimensions, internal factors is rest on the organization's continuous improvement programmed and lean management activities to reduces operation waste and this efforts relies on the organizational competencies namely dynamic capabilities to leverages green implementation (Dyllick & Hockerts, 2002) and indirectly reducing double externalities problems (Rennings, 2000). In the similar vein, Ambec & Lanoie (2008) in the articles named "*Does It Pay to Be Green ? A Systematic Overview*" proposed that both internal and external driver resulted on the positive impact of environmental and economic performance.

Comparing to the developing countries, scholars and managers in the developed countries are keen to learn about the important factors that are significant for organization to eco innovate. Klaus Rennings as one of prominence researchers with the rigorous analysis in the economics area (Schiederig et al., 2012) concluded that firm's regulation towards environmental protection as a strong factors for firm to eco innovate in product and process innovation (Horbach et al., 2012) and (Rennings, 2000). However, some scholars believed that green commitment rest on the company's initiatives and capabilities as pointed out by (Dangelico & Pujari, 2010). However, Schiederig et al., (2012) highlighted a gap in the academician literature on eco innovation management with only 136 publications in the establish database since 1990 to 2010. In conjunction with the prior argument, Dangelico & Pujari, (2010) proposed that the eco product innovation management should focus into firms resource and dynamic capabilities as mentioned in (Hart, 1995) and (Russo & Fouts, 1997) in the regression model tested, while (Verona, 1999) in the conceptual framework. To date, dynamic capabilities framework has been explain by (Crossan & Apaydin, 2010; Lawson & Samson, 2001; Smith et al., 2008) in the innovation management, new product development (Brown & Eisenhardt, 1995; Leonard-barton, 1992) and eco/green design (Johansson, 2002; Russo & Fouts, 1997).

Arising of intention in dynamic capabilities theory has knocked door for further examination in Malaysian manufacturing research particularly in the automotive industry. The Malaysian automotive industry recognises as countries growing engine and more research conducted to improve the operation and market performance (Nurulizwa, Yahya, & Samer, 2013; Rashid, Yahya, et al., 2014; Samer, Majid, Nurulizwa, & Fasasi, 2012; Yahya & Nurulizwa, 2012). Taking part of the government challenge to go green, local scholars has served varieties of report to full fill the research need. Some of them drawing a conceptual framework and others present the empirical findings of the drivers to success on eco innovation efforts. Conceptual framework proposed by Juriah Conding, Mohd Zubir, Hashim, Sri Lanang, & Fadly Habidin, (2012) and Conding & Fadly Habidin, (2013) describing companies green practices in relation the green innovation and green performance. As part of it, other authors come out with the empirical evidence to profile the success factor of green technology namely training, performance base rewards, team development, organizational culture, knowledge sharing and knowledge applications among the automotive suppliers that can be seen in (Shatouri, Omar, Igusa, & Filho, 2013). Zakuan, M. Z. M, & Hemdi (2010) in the research explore that there are five success factors; selection of material, selection of manufacturing process, design of component, legislation and International Organization for Standards (ISO) that are important for the eco design implementation. In the conclusion, research under eco innovation management between the Malaysian automotive industries is not comprehensive and proactive relative to other industries and lack of rigorous analysis as comparing other countries.

#### **4. Items Underpinning in Dynamic Eco Innovation Practices**

Trott (2008) mentioned a formula to success in market positioning is firm should stop depending on producing a superior and exciting product, but relies more on exploiting firm core competencies in knowledge, skills, management process and routines (Prahalad & Hamel, 1990). The literatures of firm's core competencies or called dynamic capabilities provide a fertile ground to bloom since the introduction of resource base view theory (RBV) by Jay Barney in 1991. Dynamic capabilities approached answering how firm generates new "value creation activities" through efficient resource management by having specific strategy and organizational process. Eisenhardt & Martin (2000) supported that the theory is representing the organizational behaviour on how renewing their assets and stock resource for the sustainability advantage (Teece, Pisano, & Shuen, 1997). As opposed to the traditional dynamic capabilities that's relies on the organizational routine (Leonard-barton, 1992; Teece et al., 1997), new concept of dynamic capabilities is referring as an organizational specific process or "firm best practice" (Bowman & Ambrosini, 2003; Eisenhardt & Martin, 2000) in effectively managing activities. According to the Eisenhardt & Martin (2000), dynamic capabilities reside in the managerial levels in return is not promising sustainable advantage, therefore firm required to effectively organize their resource base with the "synergistic activities". Thus, there were three authors describing the process of building dynamic capabilities reside the firm which is Eisenhardt & Martin (2000) and Ambrosini & Bowman, (2009) who are following Teece et al., (1997) research. The former researcher shed light on firm's dynamic capabilities can be developed through several activities namely; (i) integrate (ii) reconfigure and (iii) gain and release resources whereas the latter authors proposed on (i) reconfiguration (ii) leveraging (iii) learning and (iv) creative integration.

Researchers under the umbrella of dynamic capabilities believed that this theory is pertinent to represent organization specific strategies and management as according to Eisenhardt & Martin (2000) in order to enable innovation, new product and process development, alliances, manufacturing, human resources and organizational learning to overcome internal and external changes of environment (Teece et al., 1997). The preliminary

framework developed were discussing on firm capabilities to manage new product development based on firm core capabilities was discover by (Brown & Eisenhardt, 1995; Leonard-barton, 1992; Verona, 1999). Research performed by Leonard-barton (1992) was underline the important of utilization the organization core capabilities as its perform as a mirror of knowledge collection embedded in employee's knowledge & skills, technical systems, managerial system and values and norms. Meanwhile, Brown & Eisenhardt (1995) in their holistic research view of NPD strategy concluded that effective product development routine involved different functions or expertise such as team members, project leader, senior managers, customers and suppliers as a result for higher firm performance (Eisenhardt & Martin, 2000). In a similar vein, Verona (1999) has highlighted the important of varies functional and integrative capabilities in terms of internal-external integration and technological-marketing capabilities to advance new product and process efficiency. However, as per se, the resources based theory is full with novel variables, yet organization capabilities in return obligate an exploratory research in particular business and industry specific settings.

Table 1. Main construct for dynamic capabilities theory related to the eco innovation efforts

Main Construct for dynamic capabilities / Authors	New product development			Innovation management			Eco/green innovation	
	(Leonard-barton, 1992)	(Brown & Eisenhardt, 1995)	(Verona, 1999)	(Lawson & Samson, 2001)	(M. Smith et al., 2008)	(Crossan & Apaydin, 2010)	(Russo & Fouts, 1997)	(Johansson, 2002)
Technological capabilities	<b>R&amp;D capabilities</b> (Scientific expertise/employees skills)	X	X	X	X	X	X	X
	<b>Manufacturing capabilities</b> (Physical assets enables process Innovation)	X		X	X	X	X	X
	<b>Specific set of design capabilities</b>	X		X			X	X
	<b>Technological complementarities (knowledge)</b>			X				
External Integrative Capabilities	<b>Managerial process</b> (external communication, socialization)	X	X	X	X	X	X	X
	<b>Managerial system</b> (empowerment, incentive, recruiting)	X	X	X	X			X
	<b>Absorptive structures</b> (network of collaboration)	X	X	X	X	X	X	X
	<b>Culture and values</b> for external absorption	X	X	X	X	X	X	X
Internal Integrative capabilities	<b>Managerial process</b> (internal communication, integrative strategies, political and financial support, subtle control)	X	X	X	X	X	X	X
	<b>Managerial systems</b> (job training, collective brainstorming, incentive)	X	X	X	X	X	X	X
	<b>Integrative structure</b> (process integration, organization reengineering)	X	X	X	X	X	X	X
	<b>Culture and values</b> for internal integration	X	X	X	X	X	X	X
Marketing capabilities	<b>Market research tools</b> (empathic design)	X	X	X	X			
	<b>Strategic marketing management</b>			X	X		X	X
	<b>Marketing mix policies (4Ps)</b>			X			X	
	<b>Marketing complementariness</b>			X				

Prahalad & Hamel (1994) in their articles declared that there were ten factors embedded in the nature of competitive edge that indirectly force firm to transform firm's business model to survive. One of the most significant forces in the 21<sup>st</sup> century is much related on the environmental concern. The ideas to be environmental friendly were representing through introducing of the green product and services until product disposal. Therefore, rapid growing of authors in the area of eco innovation is emerging and they are aggressively proposing theoretical model and empirical research to support the argument on how firm could performed an eco-innovation initiatives and engaged environmental friendly mind-set to the entire stakeholders. Hart (1995) captured that firm performed sustainable competitive advantage in forms of pollution prevention, product stewardship and sustainable development (Butler, 2004). As the pollution prevention and product stewardship creating values on lowering cost and firm base competition respectively, sustainable development serve as a market positioning in the future. According to Hart (1995), the mentioned triple environmental approached needed an effective strategy for management and implementation. Thus, Russo & Fouts (1997) and Johansson (2002) conducted an empirical and conceptual research to shed light on core capabilities that's crucial for effectively implement environment initiatives . Both authors proposed a conceptual framework based on resource based perspective and (Johansson, 2002) extended the model initiated by the (Brown & Eisenhardt, 1995). The summary of core capabilities in product development, eco design and innovation management can be asses in the table 1.

In table 1.0, main construct for dynamic capabilities drawing from three main perspectives derives by the pioneers authors from each domains namely new product development (Brown & Eisenhardt, 1995; Leonard-barton, 1992; Verona, 1999), innovation management (Crossan & Apaydin, 2010; Lawson & Samson, 2001; M. Smith et al., 2008) and lastly, eco design (Johansson, 2002; Russo & Fouts, 1997). Amass findings from the previous researchers echo to the establishment of dynamic eco innovation practices in four main pillars namely **Technology collaboration, Green human resources, Eco innovation culture, and Environmental management system (EMS) strategy**. Technology collaboration can be defines as one of elements reside firm capabilities which is describing inter firm relations and enables tacit knowledge sharing between buying and supplying organization. Meanwhile, Green Human resource is part of firm's best practices in managing companies' resources related to the human or called employees to drive sustainable initiatives. "Eco innovation cultures" is defined as shared values and beliefs of the organization and served as guidance to the employee's perceptions, attitude and behaviour in their daily work. Last but not least, environmental management system Strategy acknowledged as the heart of firm best practice and described as companies specific planning and vision to be realized. The information for each measurement will be briefly explained in the next sub topic.

#### *4.1 Technology Collaboration*

In relation to technology capabilities with the dynamic capabilities theory that has been discuss earlier, there are two main theme engaged (Hofmann, Theyel, & Wood, 2012) such as an adoption of advance technology and inter firms relations to comprehend environmental management practiced. (Johansson, 2002)Johansson (2002) emphasized on the utilization of eco design support tools portrayed as CAD/CAM, life cycle analysis (LCA), product life cycle (PLC) (Pujari, 2006) to support design activities in order to increase production speed and productivity (Verona, 1999). At the heart of the technology capabilities, another important aspect rest on external network to support the innovation process (Arnold & Thuriaux, 1997). Hofmann et al., (2012) explained the technical assistance from customer and supplier is important to success in the environmental management practices for the SME companies. Conding & Fadly Habidin (2013) in reviewing conceptual framework of factor for success in automotive green practice describe that the important of customer integration in design process by providing environmental information with key suppliers (Pujari, Peattie, & Wright, 2004) and green design specification that elaborating specific environmental requirements (Zhu, Crotty, & Sarkis, 2008). Furthermore, the argument supported by the González, Sarkis, & Adenso-Díaz (2008), automotive industries embrace the environmental activities in terms of technical knowhow through close integration between customer-suppliers to fertilize environmental concern among the automotive circles. Besides that, empirical research conducted by Zailani, Eltayeb, Hsu, & Tan (2012) showed customer push factor and external technology integration (Conding & Habidin, 2013; Eltayeb & Zailani, 2009; González et al., 2008) is crucial for better environmental adoption among the Malaysian manufacturer specifically in the automotive industries (Juriah Conding et al., 2012).

#### *4.2 Green Human Resource Management*

Human resource (HR) capabilities reside in the Human resources policies and practices (Kamoche, 2000) served as a platform for firm in achieving innovation (Chen & Huang, 2009) and green technology innovation (Shatouri et al., 2013) to maintain competitive edge (Saá-Pérez & García-Falcón, 2002). Human resource management is vital and must be effectively managed by the managers as employee is the heart of firm's asset (Arnold &

Thuriaux, 1997) where skills, knowledge and expertise embedded in the individual capital must be developed to ensure work efficiency (Chen & Huang, 2009). In the similar vein, human capital must be circulated and shared inside the cooperation in attempt to achieve firm's goals and plan activities. Besides that, under the core capabilities of green human management (GHM), employee role is crucial on ensuring environmental improvement is performing as per management order. However, the cutting edge of differences between innovative human resource management and green human resource management is rest on two dimensions. In one coin, the former are embrace on the staffing, training, participation, performance appraisal and compensation as a vehicle to success in the innovation success (Chen & Huang, 2009) and (Ling, 2010). The latter are central to recruitment, training, performance management, compensation and organizational culture (Jackson, Renwick, & Douglas; Jabbour & Müller-Camen, 2011) and through the establishment of Ability, motivation and Opportunity (AMO) model (Renwick, Redman, & Maguire, 2013).

#### 4.3 Eco Innovation Culture

Smith et al., (2008) pointed that, "organization cultures" defines as a **shared values and beliefs** of the organization and providing a guidance to the employee's perceptions, attitude and behaviour (Shatouri et al., 2013) in their daily work (Govindarajulu & Daily, 2004). Organization cultures recognizes as part of firm dynamic capabilities (Leonard-barton, 1992) in order to encourages employee learning through knowledge transfer (Nonaka, 1991) and as a vehicles to support innovation adoption within the organizations (Crossan & Apaydin, 2010; Lawson & Samson, 2001; Smith et al., 2008), new product development (Leonard-barton, 1992) and eco product innovation (Pujari, 2006; Russo & Fouts, 1997). In order to leverage business sustainability, firm is free to employ any culture to achieve their desired outcomes, but they are required to balance and integrate the culture (Škerlavaj, Song, & Lee, 2010). Conceptual review conducted by Linnenluecke & Griffiths (2010) had proposed the future investigation for the corporate sustainability needs to be low on hierarchical organizational cultures, and high on departmental cultures. Due to the argument proposed by Linnenluecke & Griffiths (2010) that the organizational culture can't be shared in the entire organization due to existing of sub group in the organization. Thus, generation of new imperative which is top management are responsible to enlighten supportive culture by referring (Ramus & Steger, 2000) and (Ramus, 2001) empirical study. Ramus (2002) in her research titled "*Encouraging innovative environmental actions: what companies and managers must do*", highlighted on the application of the non-hierarchical culture which is supervisory behaviours by top management involvement towards encouraging employee environmental initiatives. (Barczak & Kahn, 2012) discovered best practice of organization culture central to the top management support on flexibility of employee's activity through communication, attitude to risk, attitude to innovation (Lawson & Samson, 2001) and tolerance of ambiguity (Smith et al., 2008).

#### 4.4 Environmental Management System Strategy

Strategy acknowledge as the heart of "best practice in new product development" and described as company's specific planning and vision to be realized (Barczak & Kahn, 2012). Strategy is essential for firms in order to accomplish designing firm's vision and mission. According to Johansson (2002), success factor for eco design lies on the management support such as vision, commitment and environmental engagement in business activities. Project leader basically communicate to team member firm's specific vision of product development (Brown & Eisenhardt, 1995). Similarly, top management shed light on the environmental goals (Banerjee, 2001; Catherine a Ramus, 2002; Sroufe, 2003) and mission statement as a guidelines towards environmental reduction (Hart, 1995). Barczak & Kahn (2012) approved the clear mission statement is important as a platform to success in designing new product development as a way to explain firm's commitment to the environment (Sroufe, 2003) and corporate mission must be appropriately translate (Nonaka, 1991) by the team members to avoid misunderstanding. Furthermore, specific environmental goals under the umbrella of new product development strategy (Cooper, 1998) and it must be clearly define and documented (Barczak & Kahn, 2012). Data from the empirical research by the several authors proven that top management support towards environmental improvement through corporate mission establishment and specific environmental goals correlated on the high implementation of environmental practice such as product design, recycling, and waste reduction (Sroufe, 2003) and environmental innovation (Banerjee, 2001; Catherine a Ramus, 2002; Rennings & Rammer, 2010; Triebswetter & Wackerbauer, 2008) respectively. The aforementioned finding was part and parcel of dynamic capabilities constructed thorough systematic literature review. Thus, through reviewing a holistic point of eco innovation management literature, have resulted on generation of performance measures for eco innovation efforts by several authors and briefly explain in table 2.

Table 2. Performance measures for eco innovation efforts highlighted by several authors

Authors	A			B			C		D		F				
	I	2	3	4	5	6	7	I	II	III	IV	V			
(Hofmann et al., 2012)	X	X	X						X	X			X		
(Pujari, 2006)	X	X			X							X			
(Pujari, Peattie, & Wright, 2004)	X				X					X			X		
(J Conding & Fadly Habidin, 2013)	X	X					X	X	X	X					
(Eltayeb & Zailani, 2009)	X							X	X	X					
(Zhu et al., 2008)	X	X					X	X	X				X		
(Theyel, 2000)	X		X				X		X				X		
(Zailani et al., 2012)		X							X						
(González, Sarkis, & Adenso-Díaz, 2008)	X						X		X	X			X		
(Russo & Fouts, 1997)			X					X	X			X			
(Govindarajulu & Daily, 2004)			X	X	X	X	X	X	X	X	X	X	X		
(Digalwar et al., 2013)			X				X						X		
(Jos & Jabbour, 2013)			X								X		X		
(Kaur, 2011)			X			X	X				X		X		
(Daily et al., 2012)			X		X			X	X	X	X	X	X		
(C. J. C. Jabbour et al., 2010)			X					X	X	X	X	X	X		
(Zahari & Thurasamy, 2012)			X	X	X		X						X		
(Shatouri et al., 2013)			X	X	X	X				X	X	X	X		
(Jackson et al., 2011)			X	X		X		X	X	X	X				
(C. Ramus & Steger, 2000)			X	X		X	X						X		
(C. A. Ramus, 2001)			X	X		X	X						X		
(Renwick et al., 2013)			X	X	X	X				X		X			
(Daily & Huang, 2001)			X	X	X	X	X						X		
(Banerjee, 2001)	X		X	X	X		X	X	X			X	X		
Johansson, 2002)	X	X	X		X	X	X	X	X		X	X			
(Daily et al., 2007)			X	X	X	X		X	X			X			
(Nee, 2011)			X	X	X	X	X						X		
(Škerlavaj et al., 2010)						X					X				
(Barczak & Kahn, 2012)		X			X	X	X					X			
(M. Smith et al., 2008)			X	X	X	X	X					X			
(Lawson & Samson, 2001)		X	X	X	X	X	X					X			
(Brown & Eisenhardt, 1995)	X	X	X	X	X	X	X					X			
(C. a Ramus, 2002)			X	X	X	X	X			X			X		
(Sroufe, 2003)							X	X	X			X			
(Rehfeld et al., 2007)							X						X		
(Wu et al., 2008)	X						X	X							
(Horbach et al., 2012)		X					X						X		
Triebswetter & Wackerbauer, 2008							X						X		
Rennings & Rammer, 2010							X						X		
(Kashmanian, Keenan, & Wells, 2010)								X	X	X	X		X		

Notes: A= Technology collaboration, B= Green human resources, C= Eco innovation culture D= Environmental Management system strategy, E= Performance

1- Supplier integration, 2- Customer integration, 3- Training, 4-rewards 5- green team 6- eco culture 7- strategy

I- economy II- ecology III- social IV- Firm (profit, market and green image) V- Firm's environmental practices

## 5. New Research Agenda: Micro Level Investigation

The new era of eco innovation research started to bloom in the new decades and open room for new research opportunities as discovered by Schiederig et al., (2012) in journal titled "*Green Innovation in technology and innovation management- an exploratory literature review*". The paper provides evidence that there are four main journals under the umbrella of eco and green innovation. Thus, the analysis begins by examining the database for the Journal of Cleaner Production, Research Policy, Technological Forecasting and Social Science, and Technovation since 2010 – 2014. Figure 3 disclose the total publication release annually with the notion of eco innovation management, green technology and sustainable development. The results similar with previous study which is Journal of Cleaner Production echoes to the green innovation research as the main theme rest on science and technology discovery. Meanwhile, for the rest of other papers, the issues bridge to the innovation management under Macro and Meso level. Even though there is growing on the numbers of publication annually, however, the shortcomings lies on the theory application as management research focus more on the stakeholder theory, intuitional theory and network theory. The circumstances resulted to the unbalance of the theoretical explanation for the eco innovation management at the micro level by utilizing resource base view and dynamic capabilities theory to describing firm initiatives to eco innovate.



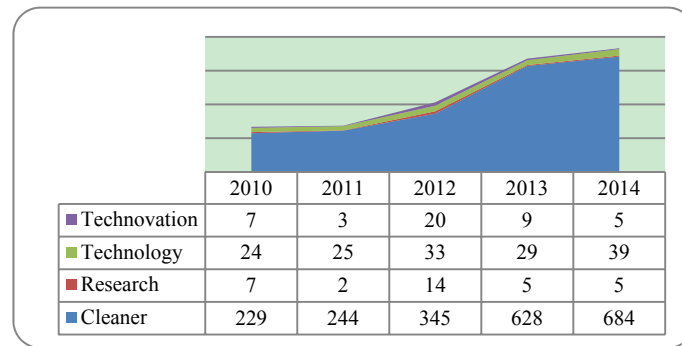


Figure 3. Trends of annual publications

The second analysis providing the top author and innovation management journal under the umbrella of **eco/environmental/green/sustainable innovation** published in these publications. The details of each author and their publication describe in table 3 below.

Table 3. Authors name and title under eco/environmental/green/sustainable innovation publications

Years	Author	Title	Journal	Citation
2010	(Carrillo-Hermosilla et al., 2010)	Diversity of eco-innovations: Reflections from selected case studies	4	119
2011	(Christensen, 2011)	Modularised eco-innovation in the auto industry	4	21
2011	(Yang & Chen, 2011)	Accelerating preliminary eco-innovation design for products that integrates case-based reasoning and TRIZ method	4	42
2012	(De Marchi, 2012)	Environmental innovation and R&D cooperation: Empirical evidence from Spanish manufacturing firms	3	82
2012	(Kesidou & Demirel, 2012)	On the drivers of eco-innovations: Empirical evidence from the UK	3	66
2012	(C. C. Cheng & Shiu, 2012)	Validation of a proposed instrument for measuring eco-innovation: An implementation perspective	1	11
2012	(González-García et al., 2012)	Eco-innovation of a wooden based modular social playground: application of LCA and DfE methodologies	4	8
2013	(Antonioli, Mancinelli, & Mazzanti, 2013)	Is environmental innovation embedded within high-performance organisational changes? The role of human resource management and complementarily in green business strategies	3	14
2013	(Jeroen & Bergh, 2011)	Environmental and climate innovation: Limitations, policies and prices	2	10
2013	(Shi & Lai, 2013)	Identifying the underpin of green and low carbon technology innovation research: A literature review from 1994 to 2010	2	5
2013	(Desmarchelier, Djellal, & Gallouj, 2013)	Environmental policies and eco-innovations by service firms: An agent-based model	2	0
2013	(Boons, Montalvo, Quist, & Wagner, 2013)	Sustainable innovation, business models and economic performance: an overview	4	37
2013	(Boons, F., & Lüdeke-Freund, 2013)	Business models for sustainable innovation: state-of-the-art and steps towards a research agenda	4	76
2013	(Horbach, J., & Rennings, 2013)	Environmental innovation and employment dynamics in different technology fields – an analysis based on the German Community Innovation Survey 2009	4	6
2014	(Marin, 2012)	Do eco-innovations harm productivity growth through crowding out? Results of an extended CDM model for Italy	3	6
2014	(A. Smith, Kern, Raven, & Verhees, 2014)	Spaces for sustainable innovation: Solar photovoltaic electricity in the UK	2	12
2014	(Epicoco, Oltra, & Saint Jean, 2014)	Knowledge dynamics and sources of eco-innovation: Mapping the Green Chemistry community	2	1
2014	(C. C. J. Cheng, Yang, & Sheu, 2014)	The link between eco-innovation and business performance: a Taiwanese industry context	4	6
2014	(de Medeiros, J. F., Ribeiro, J. L. D., & Cortimiglia, 2014)	Success factors for environmentally sustainable product innovation: a systematic literature review	4	6
2014	(Li, 2014)	Environmental innovation practices and performance: moderating effect of resource commitment	4	0
2014	(Hofstra, N., & Huisingh, 2014)	Eco-innovations characterized: a taxonomic classification of relationships between humans and nature	4	1
2014	(Ghisetti, C., & Rennings, 2014)	Environmental innovations and profitability: how does it pay to be green? An empirical analysis on the German innovation survey	4	2
2014	(Cai, W. G., & Zhou, 2014)	On the drivers of eco-innovation: empirical evidence from China	4	0

**Remarks** \*1= Technovation, 2= technological forecasting and social change 3=Research policy 4= Journal of cleaner production

## 6. Conclusion

Research under the umbrella of eco innovation central in developed countries such as Netherlands, Italy and Germany since 1990 Schiederig et al., (2012) and stimulate knowledge growth under Macro and Meso level which is focusing in the industry and national policy levels (Driessen, Hillebrand, Kok, & Verhallen, 2013). However, lack of emergent scholars in the developing countries and emphasized on the Micro level (Dangelico & Pujari, 2010; Driessen et al., 2013; Schiederig et al., 2012) mainly in technical eco innovation (Dangelico & Pujari, 2010). As there is increasing attention on measuring the precise construct that is prominent on driving firm's eco innovation effort, this research shed light on the Dynamic capabilities theory as the heart of new research opportunity. Furthermore, as recommended by Hofmann et al., (2012), it is critical to measure precisely the dynamic capabilities construct based on local context factors specially in Asia and developing countries (Rashid, Shamee, & Jabar, 2014; Rashid, Yahya, et al., 2014; Renwick et al., 2013) because of different background setting resulted on the varies drivers. Therefore, the associate factors proposed in this article was validated through systematic literature review and integrated with local findings from developing countries to maintain its originality. In the other hand, ambiguous measurement for the eco innovation performance indicated in literature and little evidence of empirical research measuring the outcomes in the triple bottom line effect in terms of economy, ecology and social development. To conclude, it's beneficial to measure the significant construct underpinning dynamic capabilities theory to describe firm's eco innovation efforts and its relationship with the triple helix performance.

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