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Environmental management and product innovation: The moderating role of the dynamic capability of small manufacturing firms

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ABSTRACT

Given the overwhelming concerns on environmental issues, our study attempts to investigate the important role of environmental management practice in the context of product exploration and product exploitation. Additionally, we examine the moderating effect of transformative capability and absorptive capability on the relationship between environmental management and product exploration and exploitation. Based on a survey of 106 managerial-level employees from small manufacturing firms in the United Kingdom (UK), this study found that environmental management practice has a positive direct effect on product exploitation and product exploration. The study also found that (1) transformative capability positively influences the relationship between environmental management and product exploration; (2) absorptive capability negatively influences the relationship between environmental management and product exploitation. From this study, we offer novel insights that extends the existing literature concerning the outcomes of environmental management within the context of product exploration and product exploitation.

1. Introduction

This study aims to extend the understanding about the relationship between environmental management and product innovation in the context of small manufacturing firms. While there has been sporadic effort to address these issues, environmental management and product innovation have their own research stream and the knowledge in both streams have been developed separately (De Medeiros et al., 2014). Though some studies (e.g. Maletič et al., 2016, 2018) have recently attempted to create a linkage between these two streams of research, studies have tended to remain at a conceptual level; hence the need for more empirical evidence to unify the current understanding from studies focusing on environmental management and product innovation.

As a response to the research gap on the role of environmental management, this study addresses the following research questions: How does environmental management impact on product innovation? And, what effect does dynamic capability have on the relationship between practising environmental management and product innovation? These research questions are derived from the inherent conundrum associated with the need on the one hand to respond to the current awareness concerning sustainability, while at the same time overcoming a challenge to introduce environmental management as a part of the product development process (Aragón-Correa and Sharma, 2003; Triguero et al., 2013). More specifically, this study responds to the recent call (e.g. Boiral et al., 2018; Maletič et al., 2016, 2018) for studying the practice of environmental management in the context of small firms. For small firms, the implementation of environmental management faces a challenge due to limited access to resources and their being bounded to

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their local context (Bromiley and Rau, 2016). Considering the limitations on small firms, this study argues that the success of introducing environmental management into product innovation is contingent on the capability to dynamically integrate, build and reconfigure internal and external resources to address rapidly changing environments (Aboelmaged and Hashem, 2019; Ferreras-Méndez et al., 2016; Gebauer et al., 2012; Teece et al., 1997).

Using a survey conducted among 106 managerial-level employees from small manufacturing firms in the UK, this study intends to make several contributions. *First*, this study provides insights on the practice of environmental management in the context of small manufacturing firms. Small firms are important and considered to be the cornerstone of sustainable development (Blackman, 2006), representing around ninety-nine percent of all enterprises (Van Hoof and Lyon, 2013). While previous literature has investigated the practice of large firms, only a few have focused on small manufacturing firms creating a paucity in understanding about the interaction among environmental management, innovation and the dynamic capability of small firms. *Second*, following recent calls (e.g. Boiral et al., 2018; Maletič et al., 2016, 2018; Ogbeibu et al., 2019; Ambec and Lanoie, 2008), this study examines the impact of environmental management on innovation activities. To be more specific, we advance current and existing works by focusing on the role of dynamic capability in moderating the relationship between environmental management and product innovation. This effort is an extension of the emerging debate in the literature on environmental management and innovation initiated by several scholars such as Maletič et al. (2016, 2018) and Ogbeibu et al. (2019). *Third*, this study helps advance both practice and research. From a practice perspective, it provides insights for small firm managers about environmental management practice, producing competitive advantage and developing environmental-friendly products. From a research perspective, it seeks to advance the theoretical linkages between environmental management and innovation management. The study also provides underpinnings for further exploration regarding the role of dynamic capability in supporting the efforts of small firms' in addressing sustainability and environmental issues.

The paper is organised as follows. We start by discussing the definition and theoretical background. Next, we hypothesize about the impact of environmental management on product innovation as well as the role of dynamic capability in moderating the relationship between environmental management and product innovation. The following section concerns with methodological aspects of the empirical study, including data collection, measurement issues and method of analysis. Descriptive results and modelling results are presented and discussed next. The paper closes with a conclusion, implications and limitations.

2. Theoretical background

2.1. Defining environmental management and product innovation

The cleaner production literature shows that environmental management is a structured and systematic approach for managing and measuring organisational environmental impacts (Xie et al., 2016b). In this study, environmental management practices are defined as actions taken by organisations including formal standards and common practices aimed at reducing the negative impact on the natural environment. The activities involve multiple functional units across the firm, namely logistics, operations, marketing and services. Environmental management has naturally been applied during the production processes (Prajogo et al., 2014; Albino et al., 2012), but it has been extended to other processes such as marketing and new product development. It involves the creation of new routines as well as re-alignment with existing operational routines aimed at reducing the impact on the natural environment (Diwekar and Shastri, 2010). The benefits from implementing environmental management has been discussed in previous studies, including new business opportunities (Montabon et al., 2007), an increase in financial performance (O'Donohue and Torugsa, 2016) and a decrease in negative environmental impacts (Ateş et al., 2012; Molina-Azorín et al., 2009).

Due to the rise in popularity of environmental management, more businesses are aware of environmental consequences during the development of products (Chen, 2011). Consumers are more prone to purchase products that consider the environment and sustainability (Makower, 2009) and are more willing to pay a premium price in supporting sustainable efforts (Chen and Chang, 2012). While the common arguments suggest that firms need to create products with core attributes that satisfy customer's needs, there has been a rise in demand for products with eco-friendly benefits (Zhang et al., 2015a,b) and especially products which have a less negative impact on the environment (Beylot et al., 2019). This situation has encouraged firms to integrate an environmental philosophy with product innovation, the aim being to prevent production waste while increasing efficiencies.

As there has been increased attention toward assimilating environmental management into innovation activity, especially during new product development, this study responds to that call by examining two types of product innovation activities, namely *product exploration* and *product exploitation* (Chan et al., 2016; Severo et al., 2017; Voss et al., 2008). *Product exploration* is defined as the extent to which firms introduce new products to meet emerging customers' demand, meet new market potential or promote the introduction of new technology in products or services. In contrast *Product exploitation* is the extent to which firms emphasize incremental innovation of products and designs to meet the needs of existing customers (Jansen et al., 2006). The effort is to expand, refine or improve the existing offering. While early studies have argued that balancing these two activities is difficult, further studies have identified the existence of ambidextrous organisations that can perform both exploiting and exploration (Kammerlander et al., 2015). However, since sustainable issues are becoming mainstream, it has been important for firms to integrate environmental management practices with both innovation activities (Pujari et al., 2003).

2.2. Environmental management, product innovation and dynamic capability

For many small manufacturing firms, capability in linking existing skills and resources to meet external pressures such as sustainability and environmental awareness is a key success in supporting growth through innovation (Dunlap et al., 2016). Compared to large firms, small firms experience limited resources which may reduce their ability to introduce environmental management into innovation activities. However, such firms are known to be more flexible and agile in transforming and reconfiguring resources. As a result, small firms' capabilities are considered to be the catalyst for practising environmental management. This is in line with the contingency perspective that believes that small firms' actions or strategies need to fit within its context – whether it is the external environment, organisational structure, or precondition factors (Mokhtar et al., 2016). In this case, the implementation of environmental management into innovation activities should be aligned with small

firms' capability in order to maximise the outcomes. The capability to dynamically integrate, build and reconfigure internal and external resources and skills to address a rapidly changing environment is critical (Eisenhardt and Martin, 2000; Winter 2003; Teece et al., 1997). Given that applying environmental management and innovation involves a high degree of change and uncertainty, dynamic capabilities can be treated as a moderator for ensuring the positive impact of environmental management on product innovation activities.

Dynamic capabilities were first introduced by Teece et al. (1997) to describe competitive advantage in dynamically changing markets. It was initially defined as the capacity of an organization to purposefully create, extend, or modify its resource base (Teece et al., 1997). However, for environmental management practice, scholar argues that the practice, innovations and its diffusion are different from other technological innovation, particularly because of the spillover effect and the impact of cleaner production variable that are locally or regionally bounded (Arbolino et al., 2018; Orlando, 2004). In understanding the green entrepreneurial orientation, Jiang et al. (2018) described dynamic capability as a mechanism to exploit new ideas and encourage innovativeness. As discussed in Horbach et al. (2012) and Aldieri et al. (2019), innovation as a part of environmental management can be identified as: (a) Market pull factor where market demands 'green' product and process, (b) technology push drivers where firms have explore new technology to make product or process 'greener', and (c) regulation to meet certain requirement for environmental performance. All those factors require firms to dynamically develop their capability. This include the capability to acquire, develop and reconfigure resources or knowledge from internal and external sources. In line with the above argument, this study considers that small firms' capability is referred to as transformative and absorptive. *Transformative capability* refers to the degree of a firm's ability to constantly redefine a portfolio of product or service opportunities based on knowledge endogenous to the firm. The term was initiated from Garud and Nayyar (1994) (transformative capacity) while referring to the exploitation of knowledge generated within an organisation to create technological advances, a new business opportunity and to increase competitive advantages. *Absorptive capability* refers to the degree of a firm's ability to recognise the value of new, external information, assimilate it, and apply it to commercial ends' (Cohen and Levinthal, 1990). It involves the assimilation process of external knowledge new to the firm with the existing internal knowledge (Wang et al., 2015). In short, transformative capability is defined as a firms' capability to utilise internal resources and knowledge while absorptive capability is the capability to absorb new resources and knowledge that are external to the firms. Fig. 1 shows the hypothetical model of this study.

2.3. Hypothesis development

2.3.1. The impact of environmental management practice on product innovation

The first hypothesis concerns the influence of environmental management on product exploration and product exploitation. Several studies (e.g. Chen and Chang, 2013; Maletič et al., 2018) have argued that environmental management practice supports product exploration. Recent findings have shown that performing exploration can be used as a predictor of innovation performance especially in competitive environments (Maletič et al., 2018). One of the reasons is that exploration is driven by desires to discover something new (Yalcinkaya et al., 2007) which involves exploration in environmental management with a long-term objective of producing products that have least negative impact on the environment (De Medeiros et al., 2014). Thus, environmental management drives small firms to realign their strategy to explore new products while at the same time focusing on emerging new customers and market needs (Molina-Castillo et al., 2011; Molina-Azorín et al., 2009). In addition, environmental management practices usually force firms to explore new areas of research and technology. This sustainability issue has attracted more firms to develop new products with "green" features as it is becoming a powerful competitive weapon in the market (Chen, 2011). For instance, many car manufacturers have advanced technology by producing car engines with cleaner combustions and better fuel economy. Based on these arguments, we posit as follow:

H1a. Environment management practice has a positive impact on product exploration activities.

Moreover, environmental management may encourage innovation through product exploitation activities. With product exploitation, firms perform innovation activities through incremental improvements such as the introduction of product variants featuring improvements and market repositioning (Levinthal and March 1993; Stone, 2006) while trying to reduce usage in materials, water and energy use (Maletič et al., 2016). Performing exploitation does not only strengthen a small firms position in the market but is also more likely to reduce the cost of operation so lower prices can be offered to consumers (Prajogo, 2016). As the objective is to consider the reduction of natural resources, water, energy, materials and other practices that minimises the negative impact on the environment (Potts, 2010), among the possible solutions are improved products that have been enhanced to offer sustainable features such as having recycled components, less packaging, being manufactured in an energy-conserved way and being less detrimental to human health (Ikram et al., 2019). When small firms implement environmental management, they potentially optimise the production process and therefore stimulate exploitation activities (Shin et al., 2008). Hence, product exploitation can be an option for small firms to achieve their environmental goals. In other word,

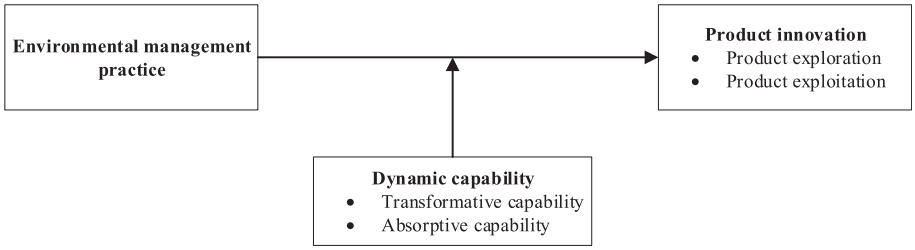


Fig. 1. Research framework and hypothetical relationships.

small firms practising environmental management are more likely to perform incremental innovation and improve their existing product(s). Based on the above arguments, we suggest that a higher level of environmental management practices would result in more encouragement to perform product exploitation. Therefore, the hypothesis is constructed as follow:

H1b. Environment management practice has a positive impact on product exploitation activities.

2.3.2. Transformative capability and its moderation role in environmental management and product innovation practices

This hypothesis argues that transformative capability is critical for the implementation of environmental management on small firm product innovation. Small firms should develop transformative capability so they can adapt their business according to the market's need and expectation such as the increasing awareness of sustainability and the environment (Wang et al., 2015). Transformative capability is an extension of dynamic capability and it explains the process of utilising internal resources to meet external demand. The transforming aspect of dynamic capabilities is needed most obviously for addressing new opportunities such as a new product that is produced with stronger environmental awareness (Dangelico et al., 2017).

Transformative capability encourages the use of internal knowledge to trigger the development of new knowledge while trying to optimise existing knowledge (Pandza and Holt, 2007). A study from Nath and Ramanathan (2016) shows that the ability to integrate internal knowledge is critical to support environmental management practice and to produce strong environmental performance. Several studies (e.g. Albino et al., 2012; Dibrell et al., 2011) found a critical condition for transformative capability is the presence of commitment and strong collaboration among units within a firm. This is so due to time saving situations such as having to "break the ice" and understanding of the social cognition of each unit. In the context of product exploration, those conditions will help firms to utilise internal resources and knowledge as a response to environmental changes. These activities often focus on exploring new opportunities such as the development of new technology or the opening of a new market as a result of new trends and perspectives to preserve the environment and sustainability. In line with the above arguments, we propose the hypothesis as stated below:

H2a. The interaction between transformative capability and environmental management practice produces a positive impact towards product exploration activities.

Similarly, transformative capability helps small firms in exploiting their current product or market. An example of a firm's transformative capability is the integration of different functional units inside an organisation which can produce internal knowledge integration, are important for firms engaging in green practices (Dibrell et al., 2011). One reason being that integration of different functional units brings different composition and levels of heterogeneity (Bercovitz and Feldman, 2011). During product exploitation, small firms perform activities to increase efficiency of the production process while introducing environmental management practices. During the process, the capability to reconfigure exiting resources and knowledge is critical to deliver the innovation within environmental management practice. In summary, combining internal resources and knowledge with understanding of the current market means small firms will be able to respond to the increased awareness of environmental performance through product exploitation. Thus, the following hypothesis is considered:

H2b. The interaction between transformative capability and environmental management practice produces a positive impact towards product exploitation activities.

2.3.3. Absorptive capability and its moderation role in environmental management and product innovation practices

This study argues that small firms' absorptive capability helps to strengthen the implementation of environmental management on innovation activities (Wang and Ahmed, 2007). Absorptive capability appears to be one of the important determinants of the firms' capability to absorb new external knowledge and to apply it to create commercial goals (Açikgöz et al., 2016). Studies have suggested that absorptive capability can assist business to capitalise on external source of innovation (West and Bogers, 2014; Harrington and Guimaraes, 2005). In order to respond to the needs of the market, small firms respond by introducing new products or improvement (e.g. upgrade, update) to existing products that support less environmental damage (e.g. avoiding production wastage) (De Medeiros et al., 2014; O'Cass et al., 2014).

Firms with high level of absorptive capability are potentially more likely to assist environmental management in succeeding product exploration. With respect to green practices, as firms increase their effort to explore new products that are sustainably featured, they usually engage with new buyers and also regulatory authorities resulting in gain of new external knowledge which provides advantage for the business to explore new product opportunities (Xie et al., 2016a). The essence of product exploration is "experimentation with new alternatives" are prone to be complex and involve uncertain returns (Zhang et al., 2015a,b). Since absorptive capability is known to enhance speed and frequency of the innovation and knowledge that it produces (Lane et al., 2006), having this capability helps to serve the firm by producing knowledge databases and unique competitive edges to support environmental practices in exploring innovation in new product ventures (Pacheco et al., 2018; Xie et al., 2016a). This element is needed in the product exploration strategy since first-movers tend to have more opportunity. Using the advantage of early access to knowledge, the firms can plan the exploration strategy more efficiently. Thus, we posit the hypothesis as follow:

H3a. Interaction between absorptive capability and environmental management practice produces a positive impact towards product exploration activities.

While the essence of product exploration is "experimentation with new alternatives" (Zhang et al., 2015a,b), product exploitation aims to develop a more efficient use of organizational resources and reduce development time and costs (Jansen et al., 2006). For product exploitation, absorptive capability provides knowledge about integrating environmental management practices into existing products or processes. Firms engaging in exploitation opportunities usually interacts with outsiders (Foss et al., 2013) to obtain a more accurate and complete assessment with what the market's need and avoiding unwanted and unimportant features (Carbonell et al., 2009). It provides the advantage of expanded range of resources beyond firms internal capacity to create solution for customer needs (Salonen and Jaakkola, 2015). This kind of external collaboration is therefore important for firms practicing environmental management in order to have a better understanding of what other competitors are practicing and current market needs, which provides a better insight of the appropriate refinement for the existing product. As absorptive capability helps firms to develop and maintain external networks, firms with a high level of absorptive capability are more likely to absorb information and knowledge about environmental management and quickly build their capability (Xie et al., 2016a). Building on the above

discussion, the following hypothesis is posited:

H3b. nteraction between absorptive capability and environmental management practice produces a positive impact towards product exploitation activities.

3. Research methods

3.1. Research setting and sample

The empirical research was conducted based on a survey of UK small manufacturing firms. We defined small manufacturing firms as having an annual turnover of less than £25 million and/or having lower than 250 employees (Department for Business, 2012). The FAME database was used to retrieve the list of manufacturers in the UK (Story et al., 2015; Deutz et al., 2013). We approached respondents from various backgrounds ranging from environmental managers to firm CEO's. In cases where no specific position was appointed to manage a firm's environmental activity, we asked for suitable respondents at managerial levels that would have access to the information that we required.

Before conducting the survey, we conducted a pilot interview among random business owners or top management representatives of small manufacturing firms. In total, we conducted pilot interviews with seven firms. The respondents were asked to complete the online questionnaire and to indicate any ambiguous or unclear phrasing of items. Besides answering the survey, respondents were also asked to provide suggestions to improve the survey. After completing the pilot test, we improved the questions and produced the final questionnaire. We employed simple random sampling where 2767 small manufacturing firms were contacted by phone between August 2016 and December 2016. To ensure respondents were comfortable answering the survey, we guaranteed anonymity (López-Gamero and Molina-Azorín, 2016). The firms that agreed to participate in the research were given a special link created specifically for that particular firm. Follow-up phone calls were made 2two weeks after sending the survey. Finally, 106 firms completed the survey giving a response rate of 5.6%. We benchmarked our response rate with previous studies from the same domain and found our response rate comparable to similar survey-based research (e.g. Gualandris and Kalchschmidt, 2016; Jabbour et al., 2014; Mitra and Datta, 2014). The demographical profile of the firm sample is presented in Table 1.

We performed some analysis regarding the collected date. The completed surveys were compared with the non-completed surveys with respect to the dependent variable to test the existence of mean difference. The results from the paired sample *t*-test showed no significant statistical difference between both categories at the significance level of 0.05, indicating absence of non-response bias (Wang and Ahmed, 2007). We acknowledge that common method bias is a source of threat since our survey was answered by a single respondent from each firm. As suggested by Podsakoff and Organ (1986), Harman's single factor test was employed to detect common method bias. The test was conducted via principle component analysis with varimax rotation. Four factors (eigenvalue>1) emerged totalling 83.28% of variance explained with no one factor accounting for more than 50% of the variance (Mattila and Enz, 2002).

3.2. Measurement and validation of constructs

Using a 7-point scale ranging from 1 for "strongly disagree" to 7 for "strongly agree", all items in the questionnaire were measured from a firm-level perspective and were treated as reflective indices. The complete items can be found in the appendix.

Product exploration ($\alpha = 0.88$) was measured using four items from Jansen et al. (2006), capturing the extent to which new products are introduced to meet market demands.

Product exploitation ($\alpha = 0.93$) is the extent to which firms emphasize incremental innovation towards existing products and measured using four items adapted from Jansen et al. (2006).

Environmental management ($\alpha = 0.89$) was examined by employing a five-item scale of environmental management adapted from Porter's (1985) value chain model. We asked respondents to rate the development of environmental management at their organisation in five areas; inbound logistics, outbound

Table 1
Firm profiles.

Demographics	Number of respondents	%
Type of business		
Chemical/pharmaceutical	4	3.8
Electrical/medical equipment/communication equipment	13	12.3
Paper/textile/printing/leather	12	11.3
Food	8	7.5
Furniture/wood/rubber/plastic product	10	9.4
Metal/machine/steel	22	20.8
Other (s)	7	6.6
Multiple industries	30	28.3
Age of firm		
Less than 10 years	4	3.8
11–25 years	20	18.9
26–50 years	47	44.3
51–100 years	24	22.6
More than 101 years	11	10.4
Number of employees		
Less than 25	13	12.3
26–50	23	21.7
51–100	37	34.9
101–250	33	33.1
Sales		
Less than £1,000,000	3	3
£1,000,001–5,000,000	21	21.2
£5,000,001–10,000,000	26	26.3
£10,000,001–25,000,000	49	49.5

logistics, operations, marketing and sales, and services. We treated this construct as a formative measure.

Transformative capability ($\alpha = 0.95$) was measured with a 5-item scale using existing scales from Gibson and Birkinshaw (2004) and Schilke (2014). Respondents were asked to rate their firm's ability to strategically adapt opportunities and knowledge within the firm.

Absorptive capability ($\alpha = 0.95$) used a four-scale measure adapted from García-Morales et al. (2008). Respondents were asked to rate their firm's ability to recognise new external opportunities and knowledge to undertake internal transformation.

Several control variables were selected based on previous literatures and the likelihood that they would affect the firm's environmental management and innovation activities. These were the firm's total years of operation, number of employees and annual sales. These variables were normalised using natural logarithm alleviate univariate non-normalities and account for non-linear effects (Feng et al., 2010).

4. Findings

4.1. Descriptive statistics and factor analysis

The study employed factor analysis to reduce the items. To measure the reliability, Kaiser-Meyer-Olkin was performed. The result shows that the sampling adequacy is 0.873 indicating reliability of the model. The constructs with eigenvalue of more than 1 represented 83.28% of variance explained. The Cronbach alpha had values of higher than 0.7 (minimum = 0.844) showing internal consistency among the constructs (Nunnally and Bernstein, 1994). The factor loading of items within the constructs had a minimum value of 0.666. Higher loading for the items are important and have a greater influence to present a factor (Hair et al., 2006). Moreover, confirmatory factor analysis was employed to establish convergent validity and discriminant validity (Fornell and Larcker, 1981). For convergent validity, this study followed the work of Mitra and Datta (2014) where average variance extracted (AVE) should be at least 0.5 and composite reliability (CR) are above 0.7. The model was overall fit where none of the items from the constructs needed to be removed. The minimum AVE was 0.666 and 0.887 for CR. For discriminant validity, following Fornell and Larcker (1981), an inter-construct correlation was conducted (Table 2). The result shows that the square root of AVE for each construct exceeded the correlation value between two constructs. Upon assessing the goodness-of-fit for our model, we confirmed that the model displayed an overall fit ($X^2 = 1.77$; GFI = 0.82; AGFI = 0.95; RMSEA = 0.09). Table 3 shows the construct and items representing the whole research model along with the item loadings, AVE and CR.

4.2. Analysis

In this study, hierarchical regression method was employed (Ferreras-Méndez et al., 2016). To detect any multicollinearity issues, two indicators were used, namely correlation between variables and the Variance Inflation Factor (VIF). The highest correlation was 0.57 while the results show no VIF's higher than 2.14. Both results show that the analysis has no issue with multicollinearity. Hierarchical regressions were conducted in five steps. In the first step, the control variables were introduced, the main effects were examined in the second step. The remaining steps were used to investigate the moderation effect. The overall results of the regression analysis are displayed in Table 4 which shows that control variables were not significant across the models. Hence, the number of years firms had been operating, number of employees in the firm and firm accumulated sales has no effect towards product exploitation and product exploration.

With regard to the effect of environmental management on product exploration and product exploitation, the analysis shows a mixed result. Model 3, 5, 7, 8 and 10 show a positive and significant relationship ($P < 0.05$), while model 2, 4 and 9 shows no significant relationship between environmental management and product exploration/exploitation. Thus, we conclude *hypothesis 1a* and *hypothesis 1b* to be supported. On one hand, the finding supports the role of environmental management on product exploration. As Prajogo et al. (2014) argue, environmental management involves a production process that relates to all aspects of product manufacturing, usage, handling, logistics and waste management, the most probable outcome is the creation of new products that abide the environmental concerns at every step of the value chain. On the other hand, the findings also support the influence of environmental management on product exploitation. The reason is that product exploitation offers the quickest and easiest way to support environmental initiatives (Maletič et al., 2014). As practicing such a strategy may jeopardise the profitability of the business, firms try to introduce environmental concerns through improvement of an existing product (Pujari et al., 2003). In this case, product exploitation may occur through minimising by-product waste and increase the use of recycled material on some aspects of the existing product (Lenox et al., 2000). Overall, the findings support the recent argument from Wang et al. (2019) that firm's environmental culture and practice are main the elements of green innovation.

The next analysis dealt with the interaction between environmental management and dynamic capability variables. To check whether transformative capability has a moderating effect on the connection between environmental management and product exploration, we observe the difference of an adjusted R^2 for the model without moderating effects (Model 2) compared to the adjusted R^2 of the model having moderating effects (Model 3 and 5). The table shows higher explanatory power in Model 3 and 5 compared to Model 2. Besides that, the moderating effect of transformative capability is significant and positive in both Models 3 and 5 proving that the interaction between environmental management and transformative capability is significant. The finding confirms *hypothesis 2a* that transformative capability strengthens the impact of environmental management on product exploration. This finding is in agreement with prior research that supports the positive impact of internal knowledge acquisition and utilisation on firm performance (Wang et al., 2015) and innovativeness (Jiang et al., 2018). In line with the concept of dynamic capability, having transformative capability promotes combination of internal resources growing into development of new products (Teece, 2016). Unfortunately, the findings failed to confirm any support for the argument that transformative capability moderates the relationship between environmental management and product exploitation. The results were insignificant based on model 8 and 10 for such a relationship. Before adding the interaction effect (Model 7), the adjusted R^2 was 13.9% but after including the

Table 2
Descriptive statistics and correlation coefficients.

	Mean	SD	1	2	3	4	5	6
Product exploration	5.13	0.13	1					
Product exploitation	5.52	1.16	.57**	1				
EM	20.12	7.61	.30**	.32**	1			
Absorptive capability	4.94	1.29	.32**	.29**	.17	1		
Transformative capability	4.33	1.52	.36**	.35**	.58**	.53**	1	
Years of operation	51.04	40.06	.08	-.01	.13	.14	.07	1

N = 106; *p < 0.05; **p < 0.01.

Table 3
Summary of measurement scales.

Items	Mean	SD	Item loading	Composite Reliability	AVE
Transformative capability				0.95	0.80
T1	4.29	1.68	0.84		
T2	4.36	1.65	0.88		
T3	4.43	1.69	0.92		
T4	4.41	1.70	0.89		
T5	4.16	1.60	0.81		
Absorptive capability				0.95	0.84
A1	5.00	1.43	0.90		
A2	4.99	1.33	0.90		
A3	4.97	1.31	0.90		
A4	4.78	1.43	0.84		
Product exploration				0.89	0.68
P1	5.30	1.44	0.64		
P2	5.24	1.67	0.85		
P3	5.18	1.61	0.89		
P4	4.79	1.68	0.81		
Product exploitation				0.93	0.78
R1	5.39	1.28	0.83		
R2	5.66	1.23	0.87		
R3	5.53	1.32	0.88		
R4	5.52	1.25	0.86		
Environmental management				0.88	0.67
E1	3.67	1.80	0.89		
E2	4.85	1.78	0.77		
E3	3.95	1.85	0.84		
E4	3.76	1.83	0.83		
E5	3.89	1.83	0.86		

Note: SD, standard deviation.

interaction effect (Model 10), the explanatory power dropped to 13.1%. Thus, *hypothesis 2b* was not supported as the result suggest transformative capability has no moderating effect on the connection between environmental management and product exploitation. One of the explanation might be due to the nature of product exploitation itself that associates with an incremental innovation and a well-defined return (Yang et al., 2014). The process might not require integration with existing knowledge to proceed such strategy as compared to product exploration strategy which involved higher uncertainty due to its more radical innovation (Maijanen and Virta, 2017). While this result in insignificant, it enhances the dynamic capability literature to argue that not all aspects of dynamic capability are able to influence firms innovation strategy.

The next analysis concerned the interaction effect of environmental management and absorptive capability. The findings (model 3 and 4) suggest that the interaction effect does not influence product exploration. Therefore, we could not support Hypothesis 3a. This result seems to indicate that, among small manufacturing firms, resources and knowledge gained from transformative capability may play an important role in determining a firm's environmental management practice towards product exploration than knowledge gained from absorptive capability. Interestingly, the finding (Model 8 and 9) suggests that the interaction between environmental management and absorptive capability has a negative impact on product exploitation ($P < 0.05$), which supports *hypothesis 3b*. One explanation could be that collaborating with external organisations to absorb new knowledge and resources will expose risks of technology leakage and also incurring a higher cost due to the collaboration process (Chen et al., 2011). Though dynamic capabilities are viewed as an enabler towards the success of organisations during changing circumstances (Helfat and Winter 2011), having the capacity to value external knowledge and ability of leveraging the external knowledge (i.e. absorptive capability) (Ferreras-Méndez et al., 2016) may not help to complement processes of product refinement and instead potentially disturb the current focus of the organisation.

Fig. 2 illustrates the role of dynamic capability in moderating the relationship between environmental management and product innovation using a simple slope analysis (Aiken et al., 1991). In the figure, the dependent variables are placed on the vertical axis while the independent variable is shown along the horizontal axis. Panel A in Fig. 2 depicts the interaction between transformative capability and environmental management on product exploration. When transformative capability is available to firms, environmental management has a positive effect on product exploration. Moreover, it also reveals that the impact of environmental management on product exploration decreases for firms with a low level of transformative capability. Panel B in Fig. 2 visualises the pattern of interaction between environmental management and absorptive capacity. The finding failed to identify a positive interaction between environmental management and product exploitation. In other words, when a firm's absorptive capability is low, its practice of environmental management leads to a stronger positive effect on product exploitation compared to when a firm's absorptive capability is high.

5. Conclusion and discussion

Business has been seeing a critical shift in that sustainability and environmental management are now top priority on many firms' agenda with the intention of ensuring a cleaner production process. Practises aimed at conserving the environment have penetrated at a deeper level of organisation from production and operational to innovation management supporting pollution preventions and reducing waste (Aragon-Correa and Sharma, 2003; Triguero et al., 2013). Facing similar pressure to consider the environment and sustainability, small manufacturing firms are now keen to adapt their business to create a cleaner production process and more efficient use of resources. The result would therefore result in an improved product or a new product that consumes less materials, uses sustainable materials, reduces waste and energy and decreases

Table 4
Result of hierarchical regression.

Variables	Product Exploration										Product exploitatio									
	Model 1		**Model 2**		**Model 3**		**Model 4**		**Model 5**		**Model 6**		**Model 7**		**Model 8**		**Model 9**		**Model 10**	
Main effects																				
Environmental management (EM)			0.04	(0.01)	0.05*	(0.02)	0.03	(0.01)	0.05*	(0.01)			0.04*	(0.01)	0.03*	(0.02)	0.03	(0.02)	0.05*	(0.02)
Transformative capability (TC)			0.12	(0.11)	0.25*	(0.13)	0.10	(0.11)	0.23^t	(0.13)			0.08	(0.10)	0.23*	(0.11)	0.13	(0.10)	0.09	(0.11)
Absorptive capability (AC)			0.23	(0.12)	0.10	(0.12)	0.25	(0.12)	0.11	(0.12)			0.19	(0.10)	0.06	(0.11)	0.15	(0.10)	0.18	(0.11)
Interaction effects																				
EM x TC					0.04**	(0.00)	0.04**	(0.01)							0.02^t	(0.01)	0.00	(0.00)		
EM x AC					−0.01	(0.01)			0.01	(0.01)					−0.04**	(0.01)			−0.02*	(0.01)
Control																				
Firm age	0.00	(0.0)	0.00	(0.00)	0.00	(0.00)	0.00	(0.00)	0.00	(0.00)	0.00	(0.00)	−0.00	(0.00)	−0.00	(0.00)	−0.00	(0.00)	−0.00	(0.00)
Firm size	0.01	(0.02)	−0.01	(0.01)	0.00	(0.01)	0.01	(0.02)	0.00	(0.02)	0.00	(0.01)	0.01	(0.00)	0.01	(0.00)	0.01	(0.01)	0.00	(0.00)
Sales	0.16	(0.09)	0.18	(0.07)	0.07	(0.09)	0.15	(0.10)	0.17	(0.08)	0.18	(0.08)	0.11	(0.10)	0.09	(0.08)	0.16	(0.07)	0.15	(0.09)
Adjusted R^2	−0.00		0.13		0.18		0.14		0.20		−0.01		0.15		0.21		0.19		0.14	
***p*-value**	0.40		0.01		0.00		0.00		0.00		0.94		0.00		0.00		0.00		0.00	

N = 106. Standard errors are in parenthesis; *$p < 0.05$; **$p < 0.01$; ***$p < 0.001$.

the inflow of raw material inputs and water (Ribeiro Massote and Moura Santi, 2013). Following the current trend in environmental management, this study aims to examine the role of environmental management on product innovation especially exploration and exploitation activities in the context of small manufacturing firms.

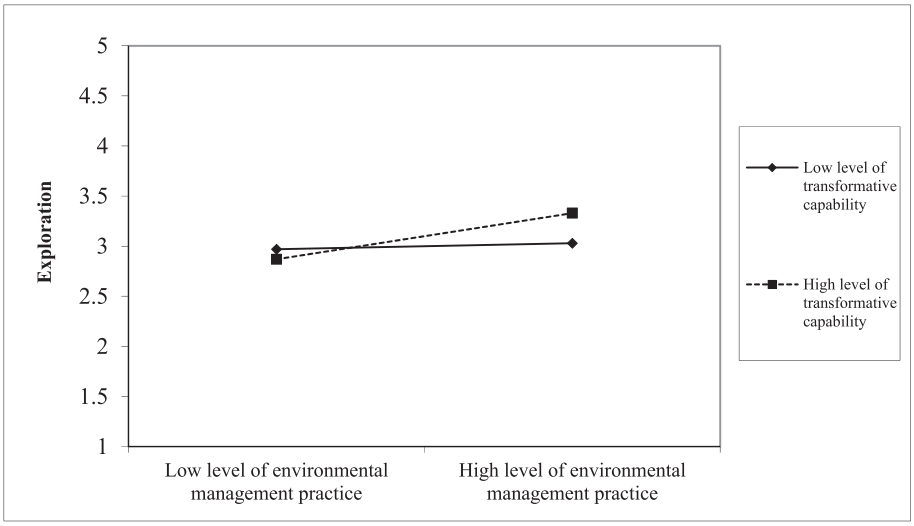
The summary of findings is shown in Table 5. This study found that environmental management practice has a positive impact on product exploration and product exploitation (H1a and H1b) which is in line with recent findings from the literature on environmental management and sustainability (e.g. Papagiannakis et al., 2019; Masri and Jaaron, 2017; De Medeiros et al., 2014; Azman et al., 2013). Moreover, the study also found that dynamic capabilities matter. The role of dynamic capabilities towards firm's environmental orientation has been confirmed in numerous recent studies (e.g. Jiang et al., 2018; Zhou et al., 2018). Furthermore, it allows them to leverage available resources and knowledge to update and exploit product innovation in response to changing business environments (Qiu et al., 2020). For product exploration, the alignment between environmental management and transformative capability produces a significant and positive impact on product exploration while environmental management and absorptive capability have a significant but negative impact on product exploitation. Generally, in most literatures, dynamic capabilities are suggested to be a strong predictor for environmental management practices among firms (Arend, 2014). However, in this study, we find that different types of dynamic capability (transformative or absorptive capability) can have different impacts depending on firm's product innovation activities.

These findings warrant further discussion. The interaction between environmental management and transformative capability *(H2a)* produces a significant and positive effect on product exploration while the same interaction has a positive but insignificant effect on product exploitation (H2b). Apparently, the capability to utilise internal resources is more effective during exploration than during exploitation activities. While on average, our samples showed that most firms are engaged with the product exploitation process ($x = 5.52$), the firms engaging in environmental management might not be dependent on internal sources of knowledge or information to aid them with the exploitation strategy. On the other hand, firms combine their internal knowledge, expertise and resources to explore opportunities in product or market as a result of implementing environmental management.

Furthermore, our results failed to confirm the role of absorptive capability (*H3a*) as a moderator for an environmental management-product exploration relationship. In most cases, absorptive capability enables firms to adapt to changes in a firms strategy to remain competitive (Winter 2003). However, in the context of implementing environmental management during product exploration, internal resources and local knowledge might be sufficient to assist firms during the product development process. This finding supports previous study such as from Braun et al. (2010) that found that in wind and solar technology, firms' absorptive capacity is more likely to utilise local knowledge spillovers than the international spillovers. Another explanation is because the small manufacturing firms in our sample comes from diverse sectors where the availability of knowledge on environmental management might have different impact. For instance, knowledge about environmental innovation for firms in chemical or pharmaceutical industry may not relevant for paper or textile firms. In other word, knowledge about applying environmental management in product innovation requires contextual understanding.

Lastly the study found that absorptive capability negatively moderates the relationship between environmental management and product exploitation *(H3b)*. This means that having a high level

Panel A: Product Exploration = environmental management x transformative capability



Panel A: Product Exploration = environmental management x absorptive capability

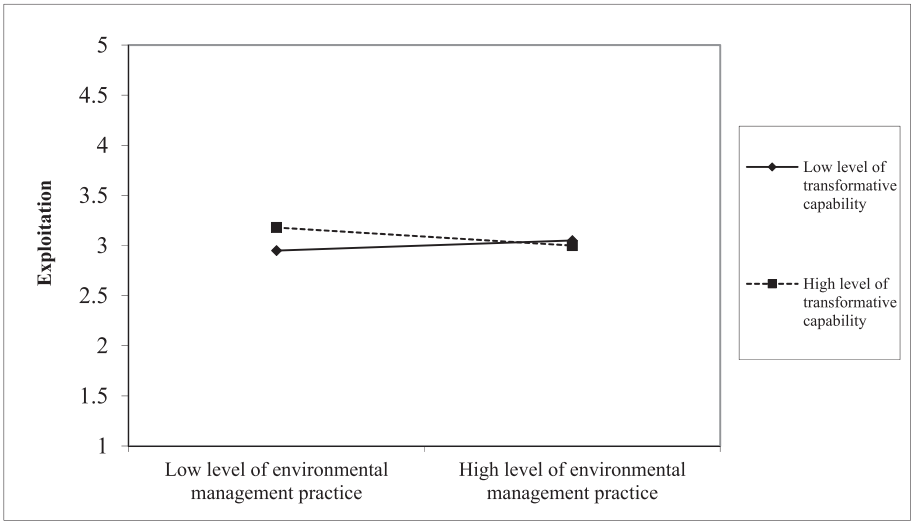


Fig. 2. Plotting significant two-way interactions.

Table 5
Summary of findings.

Hypothesis	Proposed Effects	Hypothesis Supported?
H1a: EM → Product exploration	+	Yes*
H1b: EM → Product exploitation	+	Yes*
H2a: EM*Transformative capability → Product exploration	+	Yes**
H2b: EM*Transformative capability → Product exploitation	+	No
H3a: EM*Absorptive capability → Product exploration	+	No
H3b: EM*Absorptive capability → Product exploitation	+	No**

*p < 0.05; **p < 0.01; EM: Environmental management.

of absorptive capability together with practising environmental management will result in lower engagement with product exploitation. The possible explanation is because the engagement with external networks forces firms to focus more on product exploration rather than product exploitation. In this case, the potential returns as a result of developing a new product or new market is higher than exploiting a current product or market. This finding aligns with earlier studies (e.g. Arbolino et al., 2018) that while environmental management in product innovation may produce a positive effect on the environment, it can weaken a firms productivity performance. Pacheco et al. (2018) who looked into the moderating role of absorptive capability towards organisational factors-green innovation performance, finds this capability leads to new green products but not refinement of existing products.

Moreover, the negative effect of absorptive capability might also be caused by some level of negative spillovers. In this case, the success of implementing environmental management during product innovation in one sector is associated with a decline in another sector (Truelove et al., 2014). It might be the case that firms introducing environmental management practices in their product innovation process as a result of copying other strategy without fully understanding the impact on their product, market and organisation.

5.1. Contributions of the study

The findings of this study suggest several theoretical implications. First, the findings add to the emerging stream of literature on environmental management. Previous studies focused on linking environmental management to general issues of product development (e.g. Sihvonen and Partanen, 2016) without specifying the type of activity during product development. This study extends Maletič et al.'s (2016; 2018) work in studying the impact of environmental management on exploration and exploitation activities. Our study contributes to the development of knowledge in this subject by investigating the role of dynamic capability towards environmental management and innovation management (product exploration and product exploitation).

Second, we focus on a different perspective on the measurement of environmental management. Unlike previous work (e.g. Burgos-Jiménez et al., 2013), this study defines environmental management as Porter's (1985) value chain. The advantage of this approach is the ability of the framework developed in this study to be adapted to other context or industries. This framework was established to view environmental management as a collection of function or activities that are performed by a company to create value for its customers (Porter, 1985). By reflecting on environmental management from a functional level, this study looks to overcome the common problem of latent variables as having non-observable items (Vidal-Salazar et al., 2012) which contributes towards having a more precise measurement of organizational performance.

Third, this study adds more understanding regarding the role of dynamic capabilities. Limited empirical research has ventured into environmental management, especially among small manufacturing firms. We followed the work of Wang et al. (2015) that identified dynamic capability's across firms (through a reflective construct approach). The importance of dynamic capability has been addressed over the past few years where several researchers has highlighted that specific knowledge capabilities are crucial to enhance firm's environmental practice since they connect to internal and external drivers (Melander, 2018; Hashim et al., 2015) The findings of this study show the unique characteristic of absorptive and transformative capability that has different impacts on the relationship between environmental management and innovation management. Thus, while agreeing to positive potential of firm resources, there are some attributes that may lead the implemented strategy to a reduction in terms of efficiency and effectiveness (Barney, 1991). To some extent, this study provides empirical evidences of the impact of local or contextual knowledge in the context of environmental management. As recent studies (e.g. Truelove et al., 2014; Aldieari et al., 2019) have started to open the debate regarding the positive and negative impact of knowledge spillovers, this study shows that adapting and practising environmental management especially in the context of product innovation should consider the role of locality and sectoral dimension. In this case, firms need to develop capability not only acquiring and integrating internal and external knowledge but also adapting that knowledge into their own context.

In addition to their theoretical contribution, the findings offer insights and practical recommendations. First, the results suggest that environmental management plays an important role in understanding product innovation among small manufacturing firms. Moreover, they further explain why environmental management should be prioritised among the selection of firm strategies. Second, the negative association between environmental management, absorptive capability and product exploitation reported in this study signals that small manufacturing firms wishing to pursue superior performance through environmental management need to pay more attention on their absorptive capabilities. This finding is in line with the ideas from Maijanen and Virta (2017) that associates operational capability with incremental innovations and dynamic capability with radical innovations.

5.2. Limitation and recommendation for further study

The limitations of this study offer avenues for future research. First, the sample was limited only to manufacturers categorised as small manufacturing firms. This situation limits the generalisability of the findings. Therefore, future work can be extended to medium or large firms. In addition, we included all sectors within the manufacturing industry such as metal, chemical, food, etc and so neglected the possibility that different sectors might have their own approach leading to different findings. Further study can examines the practice of environmental management in each sector. Besides that, studies that specify the sector type would be useful since there are numerous sectors generally in the manufacturing industry with various characteristics. Second, we tested the hypothesis by means of questionnaire thus providing cross-sectional data, which is limited to evaluating variables at different stages of firms' development. The older firms may accumulate knowledge and experience to adapt to environmental management practice better than young firms. Therefore, future research could be longitudinal and designed to investigate environmental management, dynamic and product innovation at firms with different ages. Third, we realised that the size of our sample is relatively small. As a result, it has impacted on the acceptance of the level of significance results (Benjamin et al., 2018). Further studies should increase the size of the sample that potentially achieve a lower threshold for statistical significance.

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No conflict of interest exists.

CRediT authorship contribution statement

Muaz Mahmud: Conceptualization, Methodology, Validation, Formal analysis, Investigation, Resources, Data curation, Writing - original draft, Writing - review & editing, Visualization, Project administration, Funding acquisition. **Danny Soetanto:** Conceptualization, Methodology, Validation, Formal analysis, Resources, Writing - review & editing, Supervision, Project administration. **Sarah Jack:** Conceptualization, Validation, Writing - review & editing, Supervision, Project administration.

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Appendix 1. Scale items used in survey

Scale Items
Environmental management
To what extent has your firm engaged in voluntary environmental activities with:
Inbound logistics
Operations
Outbound logistics
Marketing and sales
Services
Absorptive capability
How did your firm adapt to newly acquired knowledge from outside the firm?
Our firm had the necessary skills to implement newly acquired knowledge
Our firm had the competences to transform the newly acquired knowledge
Our firm had the competences to use the newly acquired knowledge
Our firm had a clear division of roles and responsibilities for acquiring new knowledge
Transformative capability
How did your firm adapt knowledge gained from within the firm?
Our firm encouraged its personnel to challenge outmoded practices
Our firm evolved rapidly in response to shifts in our business priorities
Our firm was flexible enough to allow us to respond quickly to changes in our markets
Our firm established its identity in order to be competitive in the open market
Our firm sought to determine areas of internal synergy
Product Exploration
Our firm has accepted demands that go beyond existing products and services
Our firm has invented new products and services
Our firm has experimented with new products and services in our local market
Our firm has commercialized products and services that were completely new to our organization
Product Exploitation
Our firm has frequently refined the provision of existing products and services
Our firm has regularly implemented small adaptations to existing products and services
Our firm has introduced improved iterations of existing products and services for our local market
Our firm has improved the efficiency of our provision of products and services

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