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RESEARCH ARTICLE

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Enhancing green product and process innovation: Towards an integrative framework of knowledge acquisition and environmental investment

Usama Awan[1] | Marlen Gabriele Arnold[2] | Ismail Gölgeci[3]

[1]Industrial Engineering and Management, Lappeenranta–Lahti University of Technology LUT, Lappeenranta, Finland
[2]Faculty of Economics and Business Administration, Technische Universität Chemnitz, Chemnitz, Germany
[3]School of Business and Social Sciences (Aarhus BSS), Department of Business Development and Technology, Aarhus University, Herning, Denmark

Correspondence
Usama Awan, Industrial Engineering and Management, Lappeenranta–Lahti University of Technology LUT, Lappeenranta, Finland.
Email: usama.awan@lut.fi

Abstract

Despite the increasing interest in green innovation literature, little is known on how and under what conditions firms' knowledge transfer activities affect green innovation. There is lack of research that on how particular organizational capabilities are seen more useful and how it influences on green innovation performance. To address this research gap, we examine a mediation model in which we explore whether a firm's knowledge acquisition capability and investment in environmental management mediate the impact of buyer-driven knowledge transfer activities on green product innovation and green process innovation. On the basis of an analysis of a sample of 239 manufacturing firms, we find that buyer-driven knowledge activities have a greater positive impact on green product innovation than green process innovation. Investment in environmental management fully mediates the relationship between buyer-driven knowledge transfer activities and green process innovation, and knowledge acquisition capability partially mediates the relationship between buyer-driven knowledge transfer activities and green product innovation. The current study provides evidence that internal competencies and the role of buyers in knowledge transfer are critical for explaining the green product innovation and green process innovation. Our results suggest that buyer involvement pushes firms to develop resource acquisition capability to enhance green product innovation. Our results also highlight the importance of investment in environmental management for overcoming the environmental challenges in the manufacturing firms.

KEYWORDS
green innovation, green process innovation, investment in environmental management, knowledge acquisition

1 | INTRODUCTION

Green innovation is a highly prevalent phenomenon that provides firms with the opportunity to reduce their negative impact on the environment. It enables the development of product and production processes that are less harmful to the natural environment (Huang & Li, 2017). As a consequence of environmental concerns, the manufacturing industry has geared its efforts towards the implementation of green innovation for reducing energy, pollution, recycling of ease, and utilization of remanufactured materials (Dangelico, Pujari, & Pontrandolfo, 2017). The adoption and integration of green innovation have contributed to creating more revenue opportunities and reducing environmental impact, among multinational enterprises such as Unilever, Ikea, Nike, Whole Foods, and Tesla (Williams, 2015). Green product innovation (GPdI) and green process innovation (GPcI) have provided abundant opportunities to firms for mobilizing resources to safeguard the natural environment and encourage prosperity. Evidence suggests that GPdI and GPcI have the potential to tackle environmental-related problems (Chen, 2008). As such, both GPdI and GPcI are increasingly important phenomena that have the potential to make a distinct contribution to environmental sustainability.

However, despite the relevance of green innovation as an enabler of environmental sustainability, the identification of investment decisions in technology and environmental management practices in relation to green innovation has received little attention in the literature (Guoyou, Saixing, Chiming, Haitao, & Hailiang, 2013). Moreover, although previous studies recognize the role of customer and supplier collaboration (Hofman, Blome, Schleper, & Subramanian, 2020) and managerial concern (Tang, Walsh, Lerner, Fitza, & Li, 2018) in green innovation, there is little evidence on the role of firm competencies to develop and create GPdI (Chen, 2008). Likewise, relatively very little is known about the extent to which internal firm internal capabilities influence on GPdI and GPcI (Melander, 2017).

Recent studies highlighted the importance of absorptive capacity in the adoption of external knowledge for GPdI (Zhang, Liang, Feng, Yuan, & Jiang, 2020). Similarly, the role of customer pressure and buyer involvement as drivers of GPdI and GPcI has recently been noted (Walker et al., 2014; Zhang & Zhu, 2019). Still, a much-debated question is whether foreign buyer involvement can enhance GPdI and GPcI (Guoyou et al., 2013). While extant research has investigated the antecedents of green innovation, including learning and capabilities (Albort-morant, Leal-millán, & Cepeda-carrión, 2016) and customer pressure and organizational learning (Zhang & Zhu, 2019), few empirical research studies have broadened the scope to consider specific dimensions of buyer involvement, such as buyer-driven knowledge transfer activities, especially in conjunction with absorptive capacity for the GPdI and GPcI (Dangelico, 2016). Therefore, empirical research on the role of buyer knowledge affects firms' GPdI, and GPcI still needs to be investigated (Guoyou et al., 2013).

To address the identified research gaps, this study aims to examine a mediation model in which we explore whether a firm's knowledge acquisition capability (KAC) and investment in environmental management (IEM) mediate the impact of buyer-driven knowledge transfer activities (BDKTAs) on GPdI and GPcI. Given the potential benefits of GPdI and GPcI to reduce firms' environmental impact, this study undertakes to understand how firm capabilities are affected by external knowledge (Melander, 2017). We hypothesize that BDKTAs reflected in their effect on KAC and IEM, consequently effects on GPdI and GPcI. The above linkage is in line with a mediation model wherein KAC and IEM serve mediators between BDKTAs and GPdI and GPcI. This research addresses the following research questions: (1) What effect do BDKTAs have on green product and process innovation? (2) How firms choose specific internal capabilities to respond to BDKTAs and enhance green product and process innovation?

In addressing our research questions and testing the hypotheses, we used partial least square structural equation modeling (PLS-SEM). A sample of 239 manufacturing firms in Pakistan was targeted as our sample for two main reasons. First, Pakistan, as an emerging global manufacturer, plays an essential role in international markets. Second, manufacturing firms in Pakistan have been accelerating their green innovation because foreign customers have demanded more stringent requirements for green innovation.

This study makes contributions to green innovation research by describing how KAC and IEM can be used to predict GPdI and GPcI. First, we expand the finding grounded in absorptive capacity. According to Zahra and George (2002), the extent to which firm resources are assimilated and exploited depends considerably on prior related knowledge, which can support a firm in applying knowledge to strengthen GPdI (Song, Yang, Zeng, & Feng, 2020). Here, we extracted a viewpoint that GPdI has a relationship with BDKTAs. In this vein, our results suggest that KAC channels the role of BDKTAs in enhancing GPdI. Second, our research contributes to the relative lack of empirical evidence on the nature of the link between KAC and GPcI (Melander, 2018). We advance the knowledge on the green innovation by explicating the role of IEM as a linking pin between KAC and GPcI.

Further, our result shows that internal investment in the environment enhances the firm GPcI. Although previous research has suggested that external knowledge adoption is associated with improved firm GPdI and GPcI (Zhao, Feng, & Shi, 2018), little or no research has examined the influence of BDKTAs on GPdI and GPcI. We emphasize that BDKTAs may expand the base of knowledge, expertise, and resources form, which firm can enhance their internal capability to process resources and affectively enhance GPdI and GPcI.

The study is organized as follows. Section 2 presents the literature review and the conceptual framework. Section 3 describes the research methodology, sample, and measures taken for this study. Section 4 presents the data analysis and results. Section 5 discusses the results, findings, conclusion, and finally, presents research implications, future research, and limitations.

2 | HYPOTHESES DEVELOPMENT

One of the basic characteristics that allow firms to reduce global warming is generating green products and process innovation (Arnold, 2017). Green innovation consists of two main activities. GPdI entails the generation of advanced products involving less harmful material, improved packaging, and the use of recycling and remanufactured parts and components. GPcI involves the firm propensity to improve the production process, saving and prevent pollution, and use less energy consumption (Chen & Chen, 2008).

In addition to internal research and development for knowledge creations, the sources of knowledge outside the firms have been shown to impact product and process innovation (Frenz & Ietto-gillies, 2009). Forés and Camisón (2016) found that a firm's innovation performance relies on external and internal knowledge sources to reduce environmental impact and improve energy efficiency. While, Arvanitis, Lokshin, Mohnen, and Wörter (2015) have identified that customer knowledge is important for the firms pursuing innovation. Many scholars have reported that external knowledge resources positively contribute to supplier innovation performance improvements (Xie, Zou, & Qi, 2018). Likewise, Ter, Criscuolo, and Salter (2017) believe that external knowledge sources are essential for innovation performance.

Interorganizational knowledge transfer is a fundamental source of different types of innovations (Gölgeci, Ferraris, Arslan, & Tarba, 2019; Tsai, 2001). Though knowledge transfer is typically reciprocal, buyers or suppliers may be the driving force behind it. In this regard, BDKTAs have received particular attention as a means of supplier development and innovative performance (Kim, Hur, & Schoenherr, 2015). BDKTAs denote buyers' initiatives to support their suppliers through interorganizational knowledge transfer. BDKTAs provide an opportunity for enhancing the firm's development and performance (Kim et al., 2015). We expect these opportunities provided by BDKTAs could be extended to green innovation.

Relationship with buyers is considered a crucial means of knowledge transfer and development (Saliola & Zanfei, 2009). External knowledge acquisition from key partners, that is, buyers, may have a significant impact on the development and the generation of novel ideas Liao and Marsillac (2015). Existing literature on green innovation usually states that adsorptive capacity that leverages external knowledge sources is beneficial for the integration of knowledge (Rixiao, Juanru, Yajiong, & Huigang, 2020). Laursen and Salter (2006) also show that the firm's external knowledge sources are significant in shaping a firm's propensity for green innovation. This suggests that the generation of new insights from key buyers could help firms to successfully improve and design environment friendly packaging and the use of cleaner production technologies to save energy and water resources. Thus, we expect the following:

Hypothesis 1. Buyer-driven knowledge transfer activities are positively related to green product innovation.

Hypothesis 2. Buyer-driven knowledge transfer activities are positively related to green process innovation.

Buyer-driven knowledge is an important means through which the firm brings improvements in the products and processes. That said, buyer-driven knowledge needs to be internalized and utilized through the acquirer firms' own capabilities. As a strategic capability related to absorptive capacity, KAC refers to the extent to which firms are able to systemize the process of extracting, structuring, and organizing external information (Chen, 2004). Knowledge acquisition has been linked with absorptive capacity and specific investment (Li, Cui, & Liu, 2017). Given the importance and nature of external knowledge acquisition, previous research has suggested that knowledge acquisition does not always lead to improve innovation performance (Su, Tsang, & Peng, 2009). Contrary to this notion, Zhang, Shu, Jiang, and Malter (2010) suggested that acquisition of knowledge may improve the prospects for innovation.

The theoretical lens of absorptive capacity was widely used in previous research on improving the green innovation performance (Carlo, Lyytinen, & Rose, 2012; Liao, Wu, Hu, & Tsuei, 2009). The firms can develop absorptive capacity by implementing a knowledge acquisition strategy or through external sources (Cohen & Levinthal, 1990; Forés & Camisón, 2016). In absorptive capacity literature, a firm can create cooperative strategies for knowledge acquisition and captured additional value by transforming them across the firm (Mariano & Walter, 2015). Absorptive capacity can help firms to acquire knowledge (Li et al., 2017). However, empirically, literature generally supports the view that firms' internal capabilities are essential to enhance green innovation (Li, 2015).

Furthermore, KAC is argued to facilitate innovation performance (Lee, Johnson, & Grewal, 2008). Previous research has recognized that knowledge acquisition may a substantial impact on innovation (Liao & Marsillac, 2015). We posit that firms with higher KAC are flexible to accumulate and renew available knowledge, reduce environmental impact, and improve energy efficiency through the use of recycling approaches and prevent pollution from the manufacturing process. Combining our arguments derived from absorptive capacity, we suggest that there is a mediation relationship between KAC between BDKTAs and GPdI. When partners provide expertise, capabilities to develop new products and information, a firm can shape this knowledge that can stimulate to development of innovative green products. We argue that KAC may mediate the impact of BDKTAs on GPdI. Thus, we posit the following:

Hypothesis 3. Knowledge acquisition capability mediates the effect of buyer-driven knowledge transfer activities on green product innovation.

As a result of greenhouse gas emissions, many firms have adopted environmentally responsible practices into their operations and programs (Awan, 2019). Many of these environmentally responsible practices entail substantial investments with important implications for the investing firms. Such environmental investments are reflected in the level of resources invested in environmental initiatives and the form of those investments across different types of environmental technologies/processes (Klassen & Vachon, 2003). As such, IEM represents increasing levels of investment in environmental technologies and the shift away from mere pollution control towards the significant reduction of ecological footprint, which requires the overhaul of existing production paradigms and major product and process innovations (Klassen & Vachon, 2003).

The growth of IEM has been recognized among researchers and practitioners (Power, Klassen, Kull, & Simpson, 2015). This is in line with Busch, Bauer, and Orlitzky (2016), who adopt the perspective of sustainable development: Responsible social investment is the attempt to express, and possibly promote, specific ethical values have a great positive effect on sustainable performance. Buyer firm support to suppliers is associated with on-site supplier consulting, supplier evaluation, and working collaboratively on new product development. Export manufacturing firms in a developing country are likely to have participated in joint decision making and development of technology. Empirical evidence suggests that environmental investments encourage firms to protect the natural environment

(Chatzitheodorou, Skouloudis, Evangelinos, & Nikolaou, 2019) and are a critical source of product and process innovation (Womack & Jones, 2005). IEM programs are strategically crucial for the development of infrastructure and improvement of the production process (Pagell, Krumwiede, & Sheu, 2007).

According to Claro, Neto, and Oliveira Claro (2013), sustainable investment refers to investment made in economic, environmental, and social dimensions. Previous research examined that investment in environmental programs may bring more relevance to support clean production (Ortas, Burritt, & Moneva, 2013). Power et al. (2015) suggested that IEM enabled firms to shift the production process towards waste reduction. This study describes IEM as an investment aimed to solve effectively social and environmental challenges and create a long-term sustainable value creation for most of the people and society. Specifically, the buyer promotes manufacturers to develop infrastructure as well as cooperation for joint problem solving and process improvement for investment decisions in the advanced recycling process, health, and safety issues. In turn, we expect IEM channels the influence of BDKTAs on GPcI. As such, we seek to explain how BDKTAs promote firms' IEM, which may generate novel ideas and solutions for the implementation of GPcI. This suggests that IEM may mediate the relationship between BDKTAs and GPcI. Therefore, we propose the following:

Hypothesis 4. Investment in environmental management mediates the effect of buyer-driven knowledge transfer activities on green process innovation.

Figure 1 summarizes the formulated hypotheses, generated on the current literature, in a conceptual framework.

3 | RESEARCH METHODOLOGY

3.1 | Data collection

The empirical analysis is based on data collected through a survey questionnaire of senior managers from different manufacturing firms, such as sports goods manufacturers, surgical equipment manufacturers, leather goods, textiles, and other industrial firms. Manufacturers from the developing country were chosen because they are likely to deal with different types of buyers. We pilot tested questionnaires to reduce item complexity and minimize ambiguity. Finally, the final draft questionnaire was then pretested to 17 randomly selected firms, and these firms were excluded from the final survey. We randomly identified manufacturers' firms located in different parts of the country from a list obtained from the chamber of commerce and industry. We sent questionnaires to 650 firms to senior managers. The survey was conducted in a span of 3 months, from March to May 2017. A cover letter was attached, explaining the purpose of the survey and ensure respondents' confidentiality. We received 257 useable returns, out of which 18 responses could not be included due to missing values in the final data analysis, thus resulting in 239 valid response and a response rate of 36.1%. This response rate is adequate for self-administered questionnaires, where response rates generally vary between 30 to 45% (Zhao, Feng, & Shi, 2018).

The respondents were selected using a simple random sampling method. Pakistan is an interesting context for studying the supplier's involvement with buyers related to the development of green products. Pakistan is situated in the China–Pakistan Economic Corridor and is increasingly regarded as a major emerging economy. Likewise, firms in Pakistan are increasingly becoming more integrated into global supply chains with key lead firms that support their development and increasing knowledge flow between buyers and suppliers (Bhutta, Rana, & Asad, 2007). On the other hand, the country faces pressing sustainability challenges that require major GPdI and GPcI (Ali et al., 2019; Lund-Thomsen, Nadvi, Chan, Khara, & Xue, 2012). Thus, Pakistan was deemed a proper context for testing our research hypotheses.

The survey was targeted at the seminar managers of the sample industry. The demographic characteristics of the sample are presented in (Table A1), suggested that they account for a broad range of industries. We also examined the convergent validity of the subject measures. We incorporated control variables into our data analysis. We used industry type, firm age, and employee experience because it

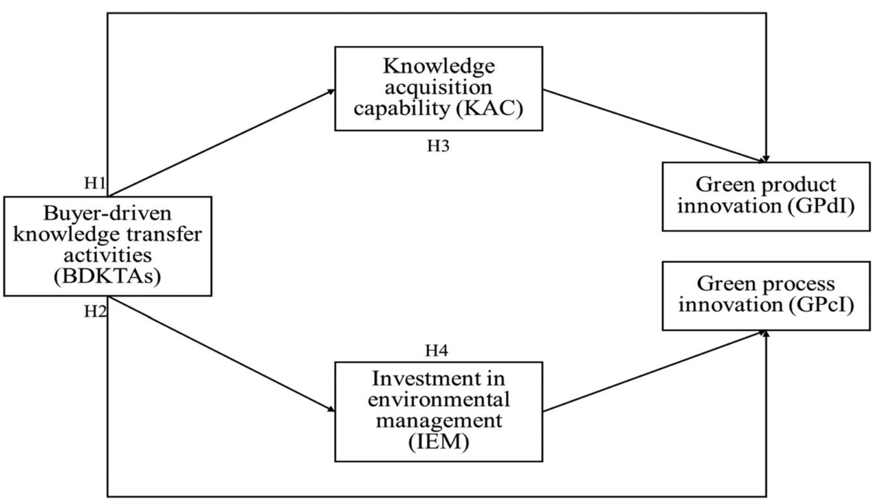

FIGURE 1 Conceptual framework

could likely act as a source of variation on green process and product innovation outcomes. Firm size was measured with the number of employees. To avoid multicollinearity in testing the hypotheses, we used a log of the number of employees. Previous studies provide evidence that firm age will assist the firm to gain more knowledge on innovation from the external environment and to identify new opportunities (Zhang & Zhu, 2019), so we controlled the firm age by taking a log of a number of years a firm is in the industry. The t-test result is insignificant, suggesting no significant differences between firm age, firm size, and industry type. We find nonresponse bias by comparing late and early respondents regarding industry type and size of the firm. The findings show no statistical difference between the two groups at a .05 level of significance. Furthermore, the result of equality of variance also supports at $P > .05$, indicating the assumption of the equality of variance between late respondents, and early has not been violated (Armstrong & Overton, 1977).

3.2 | Common method variance

We assess the common method variance (CMV) following (Podsakoff, MacKenzie, Lee, & Podsakoff, 2003) approach. We measured all our variables on a 7-point Likert scale. This helps to reduce the possibility of respondents' specific answer patterns (Zhang, Ma, Wang, Li, & Huo, 2016). Our survey questionnaires consist of multiple items, and there is a low possibility of bias occurred at the construct level that measures at the item level. Second, we employed Harmon's one-factor test. The results show that a single factor catches at most 4.7% of the variance. The result suggests that CMV is not prevalent in the chosen variables. Third, the involvement of the mediation effect as the focus of the study, it is unlikely that respondents theorized the proposed relationships while responding to the survey questionnaires (Brockner, Siegel, Daly, Tyler, & Martin, 1997). We also performed principal component analysis on all the factors; results revealed that all items loaded on their corresponding variable indicate the absence of CMB (Podsakoff & Organ, 1986).

3.3 | Measures and scale development

Multiple-item scales were used to operationalize the key variables in this study (Table A2). We drew all the measure items and scales from the prior research studies and modified within the research context. To operationalize the scale of measures, we followed the process recommended by Churchill (1979).

3.3.1 | Buyer-driven knowledge transfer activities

A scale of BDKTAs is measured by the extent to which the firm has been involved with its buyers from the last 3 years. The BDKTAs is measured as the extent to which the supplier has received support from different buyers over the past 3 years. We adapted the scales items from (Krause & Ellram, 1997; Modi & Mabert, 2007). We used the BDKTAs scale, which has been used frequently in prior research (Awan, Khattak, Rabbani, & Dhir, 2020; Kim et al., 2015).

3.3.2 | Green product and process innovation

We used 7-point Likert scale items and asked respondents to indicate the extent to which green product/process innovation improved from the last 3 years. Adapted from Chen (2008) and Chen, Lai, and Wen (2006), "green product innovation" (GPdI) and "green process innovation" (GPcI) were measured with four items. Following previous studies, GPdI and GPdI are measured on a 7-point Likert scale.

3.3.3 | Knowledge acquisition capabilities

Knowledge acquisition capabilities (KAC) is measured to the extent to which the firm has been involved with buyers and acquired knowledge resources over 3 years. We drew these items and measures from prior research. These were measured using the 4-item scales adapted by Lynn, Skov, and Abel (1999) following context adaptions.

3.3.4 | Investment in environmental management

IEM consists of the production process improvement and information on customers' needs on innovation issues. IEM was operationalized form the work of Pagell et al. (2007). IEM is measured with four items: investment in functional and process, safety practices, recycling of materials, and waste management. IEM is measured to what extent the firm has invested resources in programs over the period of 3 years on a 7-point Likert scale ranging from 1 (*not at all*) to 7 (*to a great extent*).

3.4 | Results and analysis

Table 1 depicts the descriptive statistics analysis, which provides the magnitude of correlations between the dependent and independent variables. We tested the hypothesized model using smart PLS (PLS 3.0) (Ringle, Wende, & Becker, 2015). PLS is a well-established technique in management researchers (Henseler, Hubona, & Ray, 2016). This technique provides better results in predictive and explanatory research. Factor loading of all items and average variance extracted (AVE) up above the suggested criteria support convergent validity (Fornell & Larcker, 1981). Our results meet the criteria of discriminant validity, as AVE is greater than the corresponding square multiple correlations between the measures of the constructs.

The discriminant and construct validity are evaluated following criteria described by Fornell and Larcker (1981). Table 2 reports the overall model assessment. We analyze the significant effect sizes of the relationship between the construct by considering "Cohen's effect size" (f2). We use Stone-Geisser's Q^2 evaluation criterion for the

TABLE 1 Correlations matrix

	BDKTAs	KAC	IEM	GPdI	GPcI	PE	WE	FS	FA
BDKTAs	**0.747**								
KAC	.49*	**0.748**							
IEM	.45	.39*	**0.785**						
GPdI	.29*	.11	.24*	**0.754**					
GPcI	.51*	.43*	.32*	.07	**0.741**				
PE	−.032	.048	.068	.13	.13	1			
WE	.081	.095	−.011	.07	.10	−.019	1		
FS	−.061	−.009	.041	.14	.06	−.054	.24*	1	
FA	.064	.072	−.004	0.05	0.03	.091	.20*	.29*	1
Mean	5.487	5.468	5.438	5.44	4.33	0.754	0.816	0.823	0.817
SD	0.675	0.681	0.614	1.12	1.19	0.519	0.334	0.467	0.470

Abbreviations: BDKTAs, buyer-driven knowledge transfer activities; FA, firm age; FS, firm size; GPcI, green process innovation; GPdI, green product innovation; IEM, investment in environmental management; KAC, knowledge acquisition capability; PE, level of education; SD, standard deviation; WE: Work experience.
*P < .05 level.

TABLE 2 Overall model assessment

Items	Factor loadings	AVE	CR	Cronbach's alpha
Buyer-driven knowledge activities (BDKTAs)				
BDKTA1	0.764	0.559	0.835	.742
BDKTA2	0.768			
BDKTA3	0.749			
BDKTA4	0.707			
Knowledge acquisition capabilities (KAC)				
KAC1	0.775	0.559	0.835	.740
KAC2	0.796			
KAC3	0.731			
KAC4	0.684			
Investment in environmental management (IEM)				
IEM1	0.715	0.616	0.865	.791
IEM2	0.757			
IEM3	0.840			
IEM4	0.821			
Green product innovation (GPdI)				
GPdI1	0.701	0.573	0.844	.850
GPdI2	0.814			
GPdI3	0.822			
GPdI4	0.683			
Green process innovation (GPcI)				
GPcI1	0.633	0.555	0.833	.832
GPcI2	0.850			
GPcI3	0.774			
GPcI4	0.770			

Abbreviations: AVE, average variance extraction; CA, Cronbach's alpha; CR, composite reliability.

cross-validated predictive relevance of the PLS path model (Hair & Hult, 2016). The results reported in Table 2 reveal that all composite reliability values exceeded 0.70 (Nunnally & Bernstein, 1994). The *R*-square value ranges of all construct illustrate by the model are 24.7% for knowledge acquisition and 20.4% for sustainable investment. The coefficient of determination (R^2) measures predictive accuracy and indicates the construct reliability (Hair & Hult, 2016).

The strength of the exogenous variable is measured by the effect size, where values 0.289, 0.327 and 0.256 indicate relatively medium influence, respectively (Cohen, 1992). To detect an effect size, at a .05 level of significance, requires a minimum of a sample of 92 respondents. The value of Q^2 is an appropriate criterion for determining predictive relevance for the constructs (Henseler et al., 2014). We observed that the blindfold technique produces value Q^2 > 0 for KAC, IEM, and SP at 0.012, 0.123, and 0.317, respectively. The result highlighted that the model has a powerful predictive capacity in connection to the endogenous constructs (Hair & Hult, 2016). Table 3 depicts the analysis of effect size. Further, we used Heterotrait–Monotrait (HTMT) ratios to determine the discriminant validity. Following, HTMT ratios are all less than the cut of score 0.84 (Henseler, Ringle, & Sarstedt, 2015). The HTMT rations are below 0.90, indicating the discriminant reliability of the construct.

4 | RESULT ANALYSIS AND DISCUSSION

We employed PLS with a bootstrapping procedure to obtain path coefficients. The results show a significant positive relationship between BDKTAs and GPdI (β = .239, t = 8.56, P = .05). Thus, H1 receives supports. The impact of BDKTAs on GPcI is positive and significant (β = .272, t = .092, P = .05); H2 is supported. The findings,

TABLE 3 Effect size analysis and Q^2

	f^2
BDKTAs → KAC	0.204
BDKTAs → IEM	0.569
BDKTAs → GPdI	0.234
BDKTAs → GPcI	0.265
Q^2 statistic results	
KAC	0.133
IEM	0.133
"Standardized root mean square residual": 0.0583 Q^2: Large = 0.35, medium = 0.15, small = 0.02	

therefore, suggest that BDKTAs will probably allow enhancing green innovation in product recycling, remanufacturing and reuse of material, and the use of cleaner production technologies to improve energy efficiency and save water and pollution sources. We suggest that green innovation is achieved when buyer-driven knowledge practices are part of the firm overall strategy. Participatory approaches are of clear importance. We used Baron and Kenny's (1986)) approach to test the mediation hypotheses. Further, to assess whether there is a partial or full mediation occurred, we consider Preacher and Hayes' (2008)) and MacKinnon, Fairchild, and Fritz's (2007)) guidelines to test the full or partial mediation.

Hypothesis 3 predicts that KAC mediates between BDKTAs and GPdI, as Table 4 showed. The total effect of BDKTAs on GPdI is positive and significant (β = .239, P = .05), satisfying the (Baron & Kenny, 1986) Condition 1. The results show a significant relationship exist between BDKTAs and KAC (β = .248, $P < .05$). The findings satisfying Baron and Kenny's (1986) condition 2. Moreover, KAC is positively associated with GPdI (β = .181, $P < .05$). Consistent with the expectations, we find a statistically significant relationship between the effects of BDKTAs on KAC, as shown in Table 4. The result of Preacher and Hayes (2008) test at 95% confidence interval (CI) (0.0012, 0.0554) was significant. The result indicated that the direct effect (c') remains consistent after introducing mediating variables. The findings indicate a positive association between KAC and GPdI. Most importantly, when mediation was introduced in the model, the findings provide evidence that partial mediation has occurred. Therefore, H3 is supported. Our findings are also consistent with Liao and Marsillac (2015), who found that resource acquisition influences GPcI. This suggests that a firm may benefit from BDKTAs in its effort to pursue GPdI. Hypothesis 4 predicts that IEM mediates the effects of BDKTAs on GPcI. The total effect of BDKTAs on GPcI is positive and significant (β = .153, P = .05; Table 4). Furthermore, as shown in Table 4, after introducing the IEM as a mediator between BDKTAs and GPcI, the direct effect is reduced and insignificant at 95% CI (−0.0854, 0.1357), a full mediation concluded. The findings are consistent with recent findings that investment decisions are positively associated with the improvement of GPcI (Silva, Gomes, & Sarkis, 2019). Our results highlight the importance of IEM for overcoming the environmental challenges in the manufacturing firms.

5 | DISCUSSION

Green innovation is fast becoming an imperative and instrumental source of environmental sustainability. Firms are compelled to enhance their green innovation activities and outcomes to address pressing environmental challenges and alleviate their environmental footprint. However, green innovation may be a challenging knowledge-intensive undertaking with many unknowns and complicated features. There is a lack of research on how particular knowledge resources are seen more useful and how it influences on green innovation performance. Therefore, a better understanding of enablers of key dimensions of green innovation, namely, green product and process innovation, is essential.

In this study, we investigated the effect of BDKTAs on GPdI and GPcI through resource acquisition capability (KAC) and IEM. First, the current study provides evidence that internal competencies and the role of buyers in knowledge transfer are critical for explaining the GPdI and GPcI. Second, manufacturing firms need to develop an absorptive capacity that enables them to assimilate knowledge from the buyers. This study, therefore, theoretically and empirically substantiates that BDKTAs do affect KAC and IEM. Third, consistent with

TABLE 4 Total, direct, and indirect effects of BDKTAs on SPF improvements via KAC based on 5,000 bias-corrected bootstrapped

	(c): Total effect			(c'): Direct effect			Indirect effect	
Relationship	***b***	***t***	**SE**	***b***	***t***	**SE**	***b***	**SE**
BDKTAs to GPdI	0.239	9.02	0.021	0.194	6.24	0.031	0.044	0.035
LLCI	0.3012			0.2594			0.1577	
ULCI	0.3220			0.5011			0.4248	
Total, direct, and indirect effects of BDKTAs on improvements via KAC based on 5,000 bias-corrected bootstrapped								
BDKTAs to GPcI	0.164	10.14	.016	0.098	1.36	0.07	0.66	0.023
LLCI	0.4473			−0.0854			0.0907	
ULCI	0.6629			0.1357			0.2406	

Abbreviations: BDKTAs, buyer-driven knowledge transfer activities; GPcI, green process innovation; GPdI, green product innovation; KAC, knowledge acquisition capability; LLCI, lower limit confidence interval; ULCI, upper limit confidence interval.

the literature, this study provides evidence that IEM indirectly improves process innovation, which provides distinct evidence to support the importance of BDKTAs for GPcI. Fourth, the findings suggest that KAC is a critical enabler of GPdI because the role of buyers in knowledge transfer activities can support the absorption of knowledge required for developing new green products.

In short, the finding implies that green innovation activities primarily require KAC to manage effectively external and existing knowledge resources as well as IEM to manage both green product and process innovation. We, accordingly, conclude that BDKTAs, that is, research and development, participating in employee training and skills, on-site visits, and joint problem solving, enhance the ability of suppliers to make investments in waste reduction, pollution prevention, and recycling of materials to pursue GPcI.

5.1 | Theoretical implications

The results of this research showed that KAC and IEM positively explain a firm's GPdI and GPcI, respectively. The findings of this study offer the following theoretical contributions to research on the absorptive capacity that is widely considered a critical source for knowledge assimilation and processing and apply it in a way to strengthen GPdI (Albort-Morant et al., 2016). First, we expand the findings grounded in absorptive capacity. According to Zahra and George (2002), the extent to which firm resources are assimilated and exploited depends considerably on prior related knowledge, which can support a firm in applying knowledge to strengthen GPdI (Song et al., 2020). We advance the absorptive capacity research by proposing a conceptualization of firm internal knowledge-related capabilities (i.e., KAC) in relation to GPdI. We extract a viewpoint that GPdI has a relationship with resource acquisition.

Our results suggest that BDKTAs enable firms to develop KAC to enhance GPdI. Given the widely accepted notion that buyer involvement is key to GPdI, our study illustrates the importance of the role of buyer knowledge in the development of absorptive capacity and subsequent improvement of GPdI. Here, our results are in line with the previous studies that provide evidence that through buyers' involvement in knowledge transfer and better absorptive capacity, a supplier firm can better pursue GPdI (Zhang et al., 2020).

Second, our research contributes to the relative lack of empirical evidence that tests the role of internal capabilities in the linkage between BDKTAs and green innovation (Melander, 2018). Although previous research has suggested that external knowledge adoption is associated with improved firm GPdI and GPcI (Zhao, Feng, & Shi, 2018), little or no research has examined the influence of BDKTAs on GPdI and GPcI. Accordingly, this study broadens our understanding of the influence of BDKTAs on firms GPdI and GPcI.

Third, our findings contribute to green innovation literature by bringing to the fore of understanding the environmental investment strategy for firm GPcI and environmental sustainability (Cubas-Diaz & Martinez Sedano, 2018). A few research efforts have investigated the environmental investment impact on green performance outcomes (Wu & Li, 2020). Here, our findings advance the extant research by revealing how IEM facilitates the role of BDKTAs in GPdI (Zhao, Feng, & Shi, 2018). The results suggest that the impact of BDKTAs on green process innovation is mediated by the investment in environmental management. Specifically, the study shows how investment in environmental management is used to achieve green process innovation.

5.2 | Managerial implications

This study also has implications for managers. First, our results show the importance of a firm's involvement with its buyers and supply chain partners in facilitating green innovation (Zhao et al., 2018). Manufacturers should start with a focus on assimilation and creation of knowledge resources, as beneficial forces behind innovations, to enhance their GPdI and GPcI. The buyer knowledge transfer activities may encourage supplier firms to explore novel and useful ideas (Awan et al., 2020).

Second, we find that the more buyer involvement in a firm's research and development and training initiatives, the better it is for its GPcI. Likewise, we find that firms that invest more in environmental management are in a better position to leverage knowledge opportunities and support their GPcI. Thus, managers of the firms should be made aware of the importance of environmental investment (Cubas-Diaz & Martinez Sedano, 2018), which could boost GPcI, as driven by BDKTAs. According to the results obtained, IEM is essential for GPcI, which is essential to achieve goals and targets of firm sustainability objectives.

Finally, our results show that knowledge acquisition and investment in the environment require buyer collaboration to achieve the targets of decreasing emissions in manufacturing and strengthen the ability of firms to reduce their environmental impact. Thus, with the help of external changes agents, a firm is more effective in stimulating investment if actively involved in search of resources and the implementation of change initiatives for steering more pathways (Hoppmann, Sakhel, & Richert, 2018). According to the findings, KAC, such as acquired knowledge in the production process, social initiatives to develop new products, cleaner production processes, and shared ownership vision, could reduce toxic materials and decrease material consumptions and retrieval components from the end of life products. Hence, managers should focus on external knowledge resources and better leveraging knowledge transfer activities initiated by their key buyers that are central to the development of their competences in the pursuit of green innovation.

5.3 | Limitations and future research

This study is coupled with some limitations. First, one limitation of this study is collected data from different manufacturing firms. Future researchers could target survey questionnaires to multiple respondents in a single firm. Second, this study particularly focuses on the role of buyers in a particular context, that is, green innovation. Future research studies should explore the influence of the top management with a focus on social and managerial capital perspective on a firm's environmental investment strategy on firm green innovations. Future research could assess the mechanism through which firm sustainability-orientation capability, green absorptive capacity, and research and investment decision affect firm sustainable innovation and financial performance. Our research has primarily collected data from a developing country. Future research can replicate this model and investigate the effect of broader involvement of third-tier suppliers and green absorptive capacity on the firm implementation of circular economy initiatives. Green innovation is increasingly attracting the attention of scholars and practitioners; yet, circular economy initiatives have not become a priority for sustainable product design in the global industries. Scholars are realizing the urgency of actions for circular economy initiatives aiming to reduce the adverse impacts of climate change on society and increase business performance. Investment in sustainable product design is one of the effective and sustainable approaches to deal with the rapidly increasing climate issues to support ongoing circular economy initiatives. Future research could investigate how big data management capabilities affect on the circular economy performance in the perspective of industry4.0. Third, because our study focuses on the cross-sectional method, we collected data only from key informants, and a single point of time constrains our capacity to establish causality. Further research could validate the findings by using alternative research design and data collection.

Our study examines the impact of internal organizational capabilities on green products and innovation. Circular economy initiatives and their effects on innovative product development have been a hot subject of researchers in the field of innovation management literature. Future research may investigate how digital transformation capabilities may impact the organization's readiness for change and its impact on innovation performance and circular economy performance. There is a lack of studies on how industry 4.0 tools (for example, big data, machine learning, and artificial intelligence) impact on innovation performance. Our study documented that BDKTAs is essential for GPdI. Future research may examine how team design thinking and sharing economy influence environmental performance, as well as how team agile team innovation process moderates the impact of strategic orientation on sustainable business model design.

Finally, despite the progress made in explaining the importance of the external source of knowledge transfer practices, an in-depth understanding of firm internal capabilities and external networks of existing partners is still limited (Laursen & Salter, 2006). Thus, future research can delve deeper into the interplay between internal and external sources of knowledge transfer in support of environmental sustainability.

ORCID

Usama Awan https://orcid.org/0000-0002-6185-9594
Marlen Gabriele Arnold https://orcid.org/0000-0002-6536-0301
Ismail Gölgeci https://orcid.org/0000-0002-6853-3255

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APPENDIX A

TABLE A1 Sample characteristics

Descriptive		
Industry type	*f*	%
Textile and apparel	62	25.94
Metal and engineering industry	46	19.24
Surgical instruments and related products	44	18.4
Sporting goods manufacturers	43	17.9
Leatherwear and chemical	23	0.96
Others	21	8.78
Experience	*f*	%
Less than 5	34	14.2
Between 5 & 15	123	51.5
More than 15	82	34.3
Firm size[a]	*f*	%
Less than 20	23	9.6
Between 51 & 250	101	42.3
More than 251	115	48.1
Firm age[b]	49	20.5
Less than10	58	24.3
Between 11 & 30	97	40.6
Between 21 & 30	35	14.6

[a]Firm size: number of employees.
[b]Firm age: number of years in the same business.

TABLE A2 Survey items

Items
Buyer-driven knowledge transfer activities (BDKTAs) "Please indicate the degree to which you agree to the following statements concerning your company's participation in supplier development offered by your key buyer firm over the past three years (1 = strongly disagree, 7 = strongly agree)"
BDKTA1. We actively participated in site visits and on-site (operational and managerial) consulting"
BDKTA2. "We actively participated in joint problem solving and process improvement"
BDKTA3. "We actively participated in joint new technology and product development"
BDKTA4. "We actively participated in employee trade skill training and education"
Knowledge acquisition capability (KAC) "Please indicate the degree to which you agree to the following statements concerning your company's efforts to acquire resources from your key buyer firm over the past three years (1 = strongly disagree, 7 = strongly agree)"
KAC1. "We acquired knowledge about key task involved in the production process"
KAC2. "We learned a lot about how to take social initiatives to develop new products"
KAC3. "We acquired a lot of information about the new manufacturing process"
KAC4. "We acquire a lot of information about customer needs on social issues"
Investment in environmental management (IEM) "Please indicate the degree to which you agree to the following statements concerning your company's company invested resources (money, time and/or people) in programs over past three years (1 = not at all, 7 = to a great extent)"
IEM1. "Investment in Workplace health and safety"
IEM2. "Investment in Recycling of materials"
IEM3. "Investment in Training of employee (pollution prevention)"
IEM4. Investment in Waste reduction
Green product innovation (GPdI) "Please indicate the degree to which you agree to the following statements concerning your company's green product innovation over the past three years" (1 = strongly disagree, 7 = strongly agree)"
GPdI1. "Using less or non-polluting/toxic materials (using environmentally friendly material)"
GPdI2. "Improving and designing environmentally friendly packaging (e.g.: Less paper and plastic material used) for existing and new products"
GPdI3. "Recovery of company's end-of-life products and recycling"
GPdI4. Using eco-labeling
Green process innovation (GPcI) "Please indicate the degree to which you agree to the following statements concerning your company's green process innovation over past three years (1 = strongly disagree, 7 = strongly agree)"
GPcI1. "Recycle, reuse and remanufacture material"
GPcI2. "Low energy consumption such as water, electricity, gas, and petrol during"
GPcI3. "Production/use/disposals of cleaner technology to make savings and prevent pollution (such as energy, water, and waste)"
GPcI4. "Lessor no toxicity in the manufacturing process"