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RESEARCH ARTICLE

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Green process innovation: Where we are and where we are going

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Abstract

Environmental pollution has worsened in the past few decades, and increasing pressure is being put on firms by different regulatory bodies, customer groups, NGOs and other media outlets to adopt green process innovations (GPcIs), which include clean technologies and end-of-pipe solutions. Although considerable studies have been published on GPcI, the literature is disjointed, and as such, a comprehensive understanding of the issues, challenges and gaps is lacking. A systematic literature review (SLR) involving 80 relevant studies was conducted to extract seven themes: strategic response, organisational learning, institutional pressures, structural issues, outcomes, barriers and methodological choices. The review thus highlights the various gaps in the GPcI literature and illuminates the pathways for future research by proposing a series of potential research questions. This study is of vital importance to business strategy as it provides a comprehensive framework to help firms understand the various contours of GPcI. Likewise, policymakers can use the findings of this study to fill in the loopholes in the existing regulations that firms are exploiting to circumvent taxes and other penalties by locating their operations to emerging economies with less stringent environmental regulations.

KEYWORDS

clean technology, end-of-pipe solutions, green innovations, green process innovation, systematic literature review

1 | INTRODUCTION

Nations around the globe have prioritised economic and industrial growth over the past few decades, often at the expense of the environment. This growth has mainly relied on conventional technologies, which suffer from inefficient energy consumption and severe greenhouse emissions and thus lead to global warming (J. Dai et al., 2015). Per the Intergovernmental Panel on Climate Change (IPCC), global warming increases the intensity of extreme weather changes, which causes a rise in the sea level and the melting of glaciers, thereby threatening the existence of life on earth (IPCC, 2013). There is thus a dire need to switch from fossil fuel-led energy-inefficient technologies to focus more on clean and green technologies that are not only energy efficient but also help in pollution and emission reduction in the production processes (Erzurumlu & Erzurumlu, 2013). Furthermore, while green technologies have the ability to control the emission of greenhouse gases into the environment, they also have the potential to address the dilemma of economic growth. Given that governments are less willing to adopt alternative technologies if they compromise their economic and industrial growth, green technologies are particularly promising as they help in energy efficiency and emission reduction at the same time (N. Zhang, Liu, et al., 2017).

In the developed world, firms are supposed to adhere to an emission cap and are penalised with carbon tariffs based on emission leakages. Although the industrialised nations in the first world have taken significant policy steps to fight the emissions generated in the production processes, developing economies have chosen to prioritise their economic goals instead (Masoudi & Zaccour, 2013). This tendency has led to the *Pollution Haven Hypothesis* (PHH), in which firms exploit these loopholes by shifting their operations to developing countries, thereby avoiding the higher tax rates, stricter audits and punishments that they would face on domestic soil (Eyland & Zaccour, 2014).

Faced with criticism and sanctions, the developing countries have started to catch up with the trend and have begun to announce similar policy measures. One such example is China, which has announced a carbon emissions cap and enacted different tax rates on goods produced for domestic consumption and exports separately (Zhao et al., 2014). Furthermore, a separate department has been created under the Ministry of Ecology and Environment to set emission caps and ensure the proper implementation of these and other related policy decisions, thus reflecting the sensitivity and commitment of the Chinese government towards environmental issues (R. Dai & Zhang, 2017). It, therefore, becomes increasingly difficult for firms to relocate production facilities to pollution safe-havens, forcing them to either adopt green technologies or pay additional fines and penalties. Apart from the regulatory measures, normative pressures also exert a significant impact on firms to adopt green process innovations (GPcIs). As customers are becoming more sensitive to environmental issues, they are demanding an end to polluting technologies while calling for products made using green technologies (Huang et al., 2016). Therefore, firms have to adopt green production technologies and related equipment in their production process to retain their customer base, whose interest in such technologies has been increasing exponentially (R. Dai & Zhang, 2017).

As a sub-dimension of green innovation, GPcI has received significant attention from the researcher community. However, the literature is disjointed, with different terms being used to discuss production-related issues, which include but are not limited to green innovation, GPcI, eco-process innovation, environmental process innovation, clean process innovation and so on. Furthermore, the scope of issues discussed is similarly diffuse as research has been published in heterogeneous journals ranging from policy matters to consumer behaviour. Although one noteworthy bibliometric review has been conducted on green innovation (Karimi Takalo et al., 2021), the selected literature included green product innovation, green managerial innovations and green marketing innovations in addition to GPcI (Abu Seman et al., 2019), making its scope too broad to capture the issues, challenges and gaps specific to the GPcI literature. In comparison, the current study systematically reviews the relevant literature on GPcI published to date to provide a comprehensive picture of the issues and challenges faced by firms in their transition from conventional polluting and inefficient technologies to GPcI. A systematic literature review (SLR) study not only helps in synthesising the literature to broaden our understanding of relevant issues but also helps in developing a comprehensive framework that guides the management and other external stakeholders. In line with these arguments, the present study sets out four research questions (RQs): RQ1. What is the research profile of prior relevant studies published on GPcI? RQ2. What are the different research themes and focus areas studied in the selected studies? RQ3. What are the various limitations and gaps in the prior literature? RQ4. In what ways can the research and practice in GPcI be taken forward?

To address these RQs, we utilised stringent systematic review criteria set forth by Dhir et al. (2020), Seth et al. (2020), T. M. et al. (2021) and Talwar et al. (2020). RQ1 was addressed by extracting the research profiles of the selected studies after explaining the conceptual boundary, database selected, keywords used and shortlisting criteria. To address RQ2, we organised the studies into seven themes, based on our understanding from the content analysis, composing of *strategic response*, *organisational learning*, *institutional pressures*, *structural issues*, *outcomes*, *barriers* and *methodological choices*. To answer RQ3, we critically analysed the selected studies and presented theme-based open research gaps as well as the associated potential RQs. Finally, we responded to RQ4 by (a) developing a framework that aims to provide a high-level picture of the different contours of GPcI and (b) discussing the various implications of this study for business strategy and practice.

As GPcI concerns energy consumption and environmental pollution, its adoption is driven by sustainable development goals. Consequently, the research contribution, in terms of academic papers, has remained largely disjointed with varying audiences. Therefore, the outcomes of this SLR would be of interest to different stakeholder groups, ranging from scholars to policymakers and to people holding significant managerial positions with the discretion to alter their firm's course of action. Scholars can further take note of what has been done and what needs to be done regarding research contributions. The practitioner, meanwhile, can get a holistic understanding of the various issues, challenges and potential benefits of GPcI to make better, more informed decisions. The study is of immense benefit for policymakers, especially in the developing world, as they can utilise the findings to bring course-altering regulations and penalties so that the adoption of GPcI by firms is hastened.

This SLR is organised into seven sections. In this first section, we outlined the introduction; in the second section, the scope and boundary conditions for this study are set. The third section focuses on the methodology used to identify relevant studies, whereas the fourth section discusses the emergent themes in the GPcI literature. In the fifth section, we highlight the gaps in this literature and the potential RQs that future researchers can then address. The sixth section provides the framework of this study, whereas the seventh section concludes our findings with appropriate implications for business strategy and practice.

2 | SCOPE OF THE REVIEW

GPcI refers to the adoption and implementation of technologies that reduce energy consumption in the production processes

(Salvadó et al., 2012). More specifically, GPcI involves making a transition from conventional energy sources to bioenergy so as to reduce the total energy consumption and greenhouse emissions (Kivimaa & Kautto, 2010). The literature on green innovation has divided GPcI into clean technologies and end-of-pipe solutions (Chiou et al., 2011). Clean technologies are designed to efficiently utilise resources and energy while reducing emissions in the production processes, whereas end-of-pipe solutions are tailored to capture and treat emissions and pollution at the end of the production process (Berrone & Gomez-Mejia, 2009). Although end-of-pipe solutions may not be as essential in the overall production process as clean technologies, they significantly reduce emissions and improve the waste management practices of firms and nations, leading to cleaner water bodies and the overall natural environment (Chiou et al., 2011). This study, therefore, focuses on GPcI for two reasons. First, based on our understanding from the green innovation literature, firms consider offering green products easier than switching to GPcI due to the high costs involved and longer pay-back periods (Kassinis & Vafeas, 2006). Therefore, it is crucial to unravel the various factors that can help the practitioner and policymakers take adequate steps to exert pressure on firms to switch to GPcI. Second, although a few noteworthy SLR studies have been conducted on green product innovations (e.g., Dangelico, 2015), to the best of our understanding, no SLR has yet been undertaken on GPcI to date.

To select the relevant studies on GPcI, we followed a two-step procedure. In the first step, we included research articles that used 'green innovation' in the title but measured GPcI in the paper. Second, the literature on GPcI has used different terms for process innovation, including eco-process innovation, eco process innovation, green technology innovation, clean technology innovation, sustainable process innovation and environmental process innovation. We compared the definition and scale items utilised in these studies and, based on our understanding of the results, either included or excluded the articles. Specifically, this SLR includes those studies (Figure 1) that are congruent with the definition and scale measures of GPcI studies.

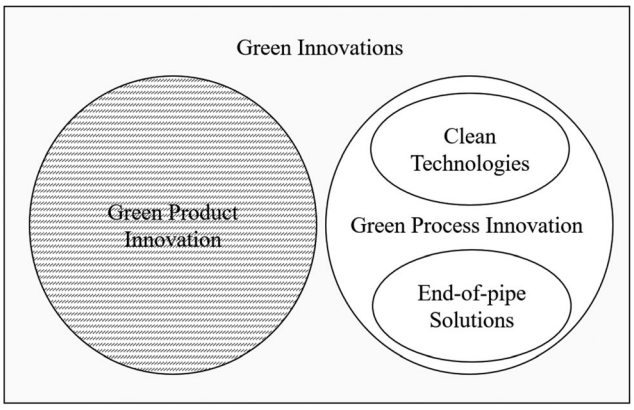


FIGURE 1 Scope of this study

3 | RESEARCH METHOD

The aim of this study was to undertake a comprehensive and critical review of the studies that have been published on GPcI using the SLR methodology. This methodology was chosen due to its interdisciplinary acceptance as the preferred method of reviewing studies, especially across different areas of management research (Talwar et al., 2020), and its ability to reproduce similar results (Seth et al., 2020). There are different suggestions in the literature about the steps to be followed while conducting the SLR to ensure that future similar studies can replicate or extend it (Dhir et al., 2020; Seth et al., 2020; Talwar et al., 2020; T. M. et al., 2021). The current study is in line with the arguments of these researchers; accordingly, we have utilised a four-step process, which includes: Step I: Planning the review; Step II: Specifying the screening criteria; Step III: Data extraction; and Step IV: Data execution.

3.1 | Planning the review

GPcI is a subtopic within the green innovation literature. With the aim to include the maximum number of studies on GPcI, we began by searching two keywords: '*green process innovation*' and '*green* AND *process innovation*'. These keywords were initially searched on Google Scholar before the first 100 results were analysed to update our list of keywords. We then searched the leading journals on energy, green innovation and sustainability to assess whether our keywords were exhaustive or not. To ensure a bias-free research profiling of the studies, we assembled a review panel consisting of one professor, one practitioner and two researchers. After consulting this panel, we further added *eco-process innovation*, *eco process innovation*, *green technology innovation*, *clean technology innovation*, *sustainable process innovation* and *environmental process innovation* to the list. Finally, the selected keywords were used to search and retrieve studies from the Scopus and Web of Science (WoS) databases as they include a comprehensive list of reputed journal articles, especially in the field of the social sciences (Mongeon & Paul-Hus, 2016).

3.2 | Screening criteria

After the keywords selection, exclusion and inclusion criteria were specified to screen the studies. The inclusion criteria required the studies to be (a) peer-reviewed, (b) published in the English language on or before the 17th of January 2021 and (c) primarily focused on GPcI. The exclusion criteria mandated the removal of studies that were (a) not congruent with GPcI; (b) not directly related with GPcI, for example, green process innovations; (c) appearing twice with matching author, title, volume, issue number and digital object identifier (DOI); and (d) reviews, conceptual papers, thesis papers, editorials and conference proceedings.

3.3 | Data extraction

Utilising * and Boolean logic and 'OR' and 'AND' connectors, the keywords were converted into search strings (Figure 2). A total of 619 articles published in the English language were found, which included 419 articles in Scopus and 200 articles in the WoS database. After applying the pre-specified inclusion and exclusion criteria, 240 duplicate articles were identified and excluded using Microsoft Excel spreadsheets. The remaining 379 articles were further screened based on the exclusion criteria, and 242 articles were further excluded from the list. At this stage, two authors of this study further synthesised the remaining studies individually using the pre-specified exclusion criteria. They were allowed to share their results once they were done screening the articles so that they could discuss any differences in the shortlisting procedure to arrive at a consensus. After several rounds of discussions, the researchers finally agreed to remove 61 articles, which they found to be inconsistent, from the list. The final list of 76 studies was then examined by one practitioner and a professor having experience in green innovations, who then agreed with the filtered down list. However, while running a backward and forward search of these articles, the authors further extracted four articles that were not identified in our initial search and added them to the list.

3.4 | Research profiling

The research has been presented in terms of different statistics related to the year-wise publications on GPcI, publishing journals, the geographic scope of studies, theoretical frameworks used, methods and sample used, respondent profile and the top-cited journals, as these help in better understanding the GPcI literature conducted over the years. The review suggests that increased scholarly attention has been paid to GPcI research over the past 3 years and that the trend is growing (see Figure 3). Most of the studies (see Figure 4) have been published in the *Journal of Cleaner Production*, *Sustainability* and *Business Strategy and the Environment*, highlighting the strategic focus of researchers. However, most of the studies have been conducted in China (see Figure 5), which limits our understanding of the issues and challenges faced by firms in other economies. The selected studies have mostly utilised stakeholder theory, the resource-based view (RBV) and institutional theory to understand the various antecedents, consequences and issues related to GPcI (see Figure 6). Although regression and structural equation modelling techniques (see Figure 7) have mostly been used to analyse the data, most of the results of these analyses are based on primary data (Figure 8), collected mostly from top-level management (see Figure 9), which limits our understanding and the generalisability of the results. Finally, Figure 10 reveals the top-cited journals, highlighting their contribution to green innovation in general and GPcI in particular.

4 | THEMATIC FOCI

The selected studies ($N = 80$) of this review were critically analysed with a focus on better understanding the various antecedents, consequences and challenges of GPcI. To synthesise this diverse set of studies, we undertook a thorough review and content analysis of each paper to unravel common themes, in line with the recently published SLR studies (Dhir et al., 2020; Seth et al., 2020; Talwar et al., 2020).

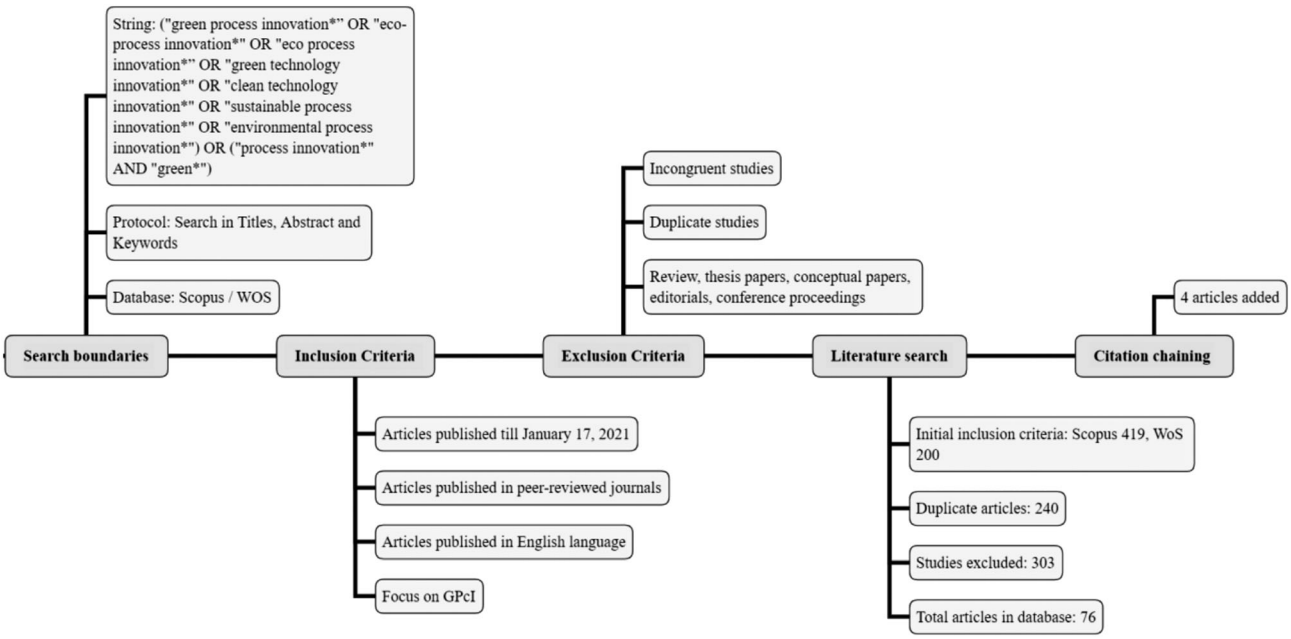


FIGURE 2 Systematic literature review methodology adopted to select relevant articles. GPcI, green process innovation; WoS, Web of Science

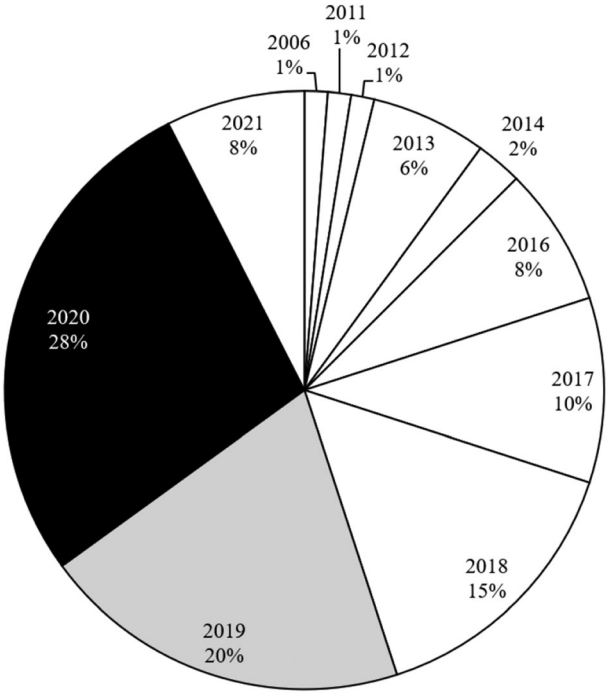
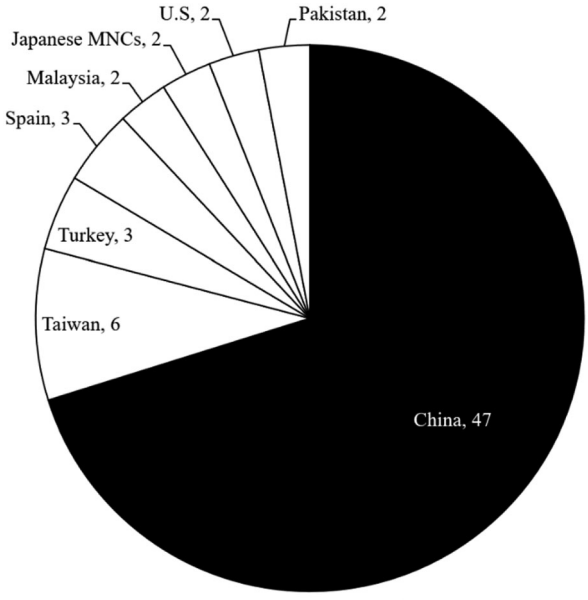
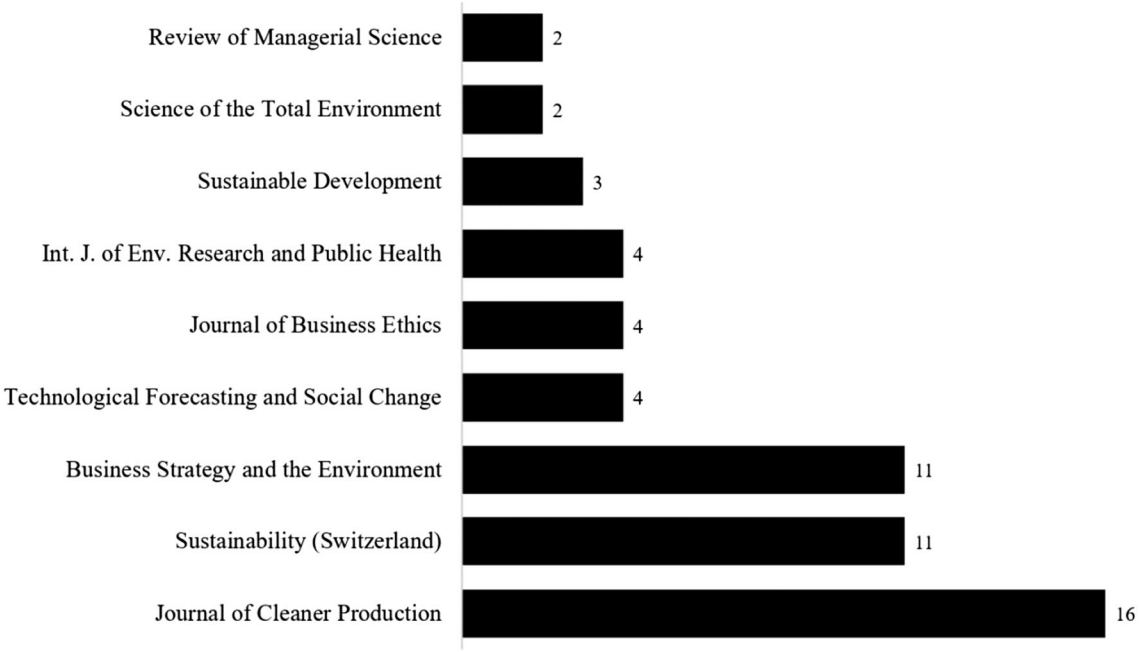


FIGURE 3 Year-wise distribution of the selected studies published on green process innovation



Note: The figures in brackets represent the number of studies which have used sample from the respective countries. Other studies were conducted on samples from Latin America, Iran, Thailand, MENA region, European SMEs, Brazil, Hong-Kong and Korea (one study each). Two studies were conducted on samples from a panel of 71 countries.

FIGURE 5 The geographic scope of studies conducted on green process innovation



Note: Other journals that published one study each include International Business Review, Journal of Manufacturing Technology Management, Energy Policy, Australasian Marketing Journal, Natural Hazards, International Journal of Innovation Management, Sustainable Production and Consumption, International Journal of Production Economics, Journal of High Technology Management Research, International Journal of Production Research, Mathematics, Journal of Business & Industrial Marketing, Resources, Conservation and recycling, IEEE Transactions on Engineering Management, Supply Chain Management, Technology in Society, European Journal of Innovation Management, CSR and Environmental Management, Applied Energy, Ecological Economics, Asia Pacific Journal of Management, Journal of Environmental Management, Journal of Business Research.

FIGURE 4 Journal-wise distribution of the selected studies published on green process innovation

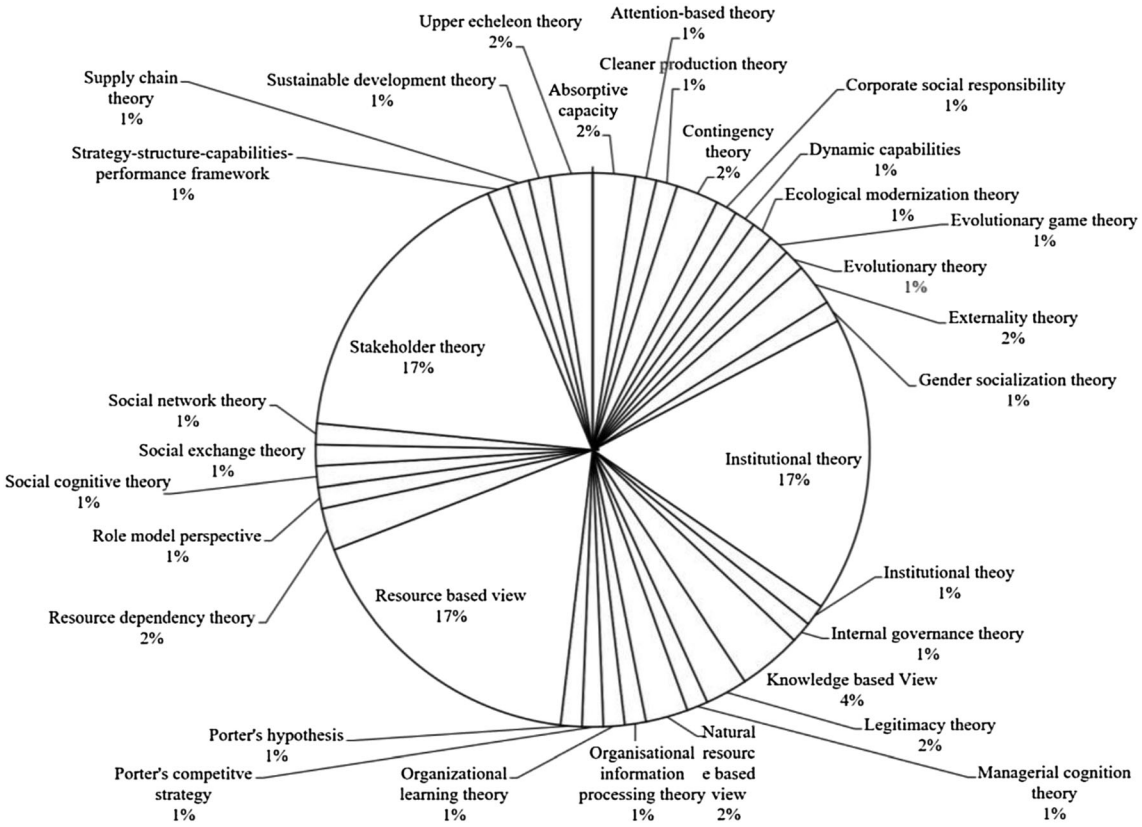
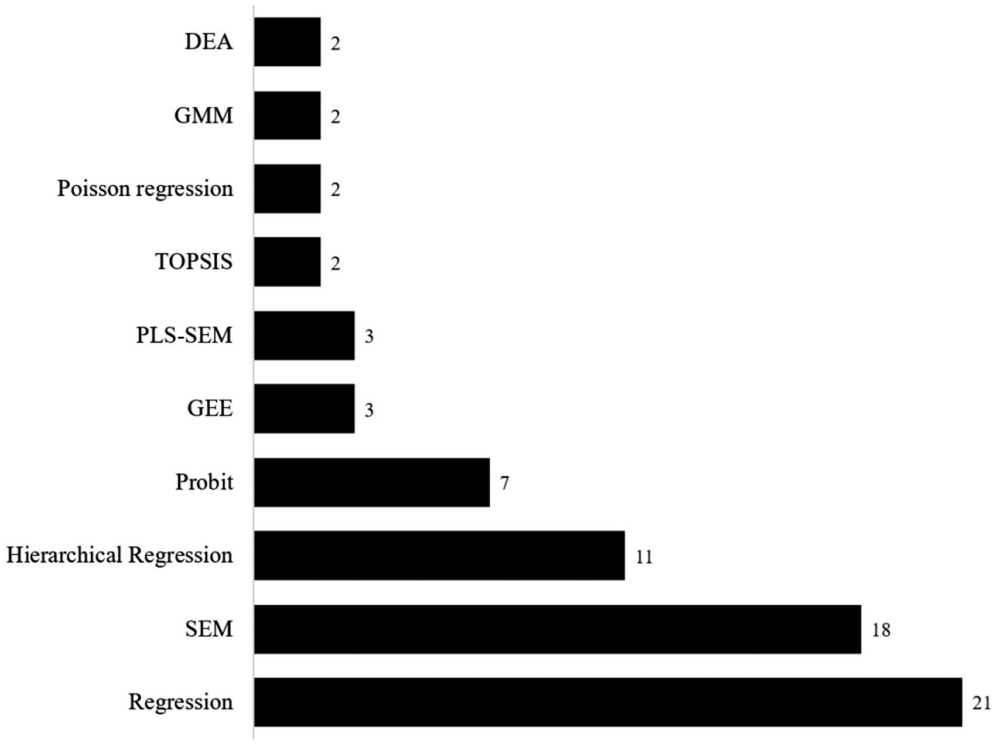


FIGURE 6 The theoretical framework utilised by the researchers in their studies on green process innovation



Note: Other studies have utilized MANOVA, ANOVA, Feasible generalized least square, Dynamic panel threshold model, Stochastic frontier analysis and Difference-in-differences model.

FIGURE 7 Graphical representation of the methods used in the selected green process innovation studies

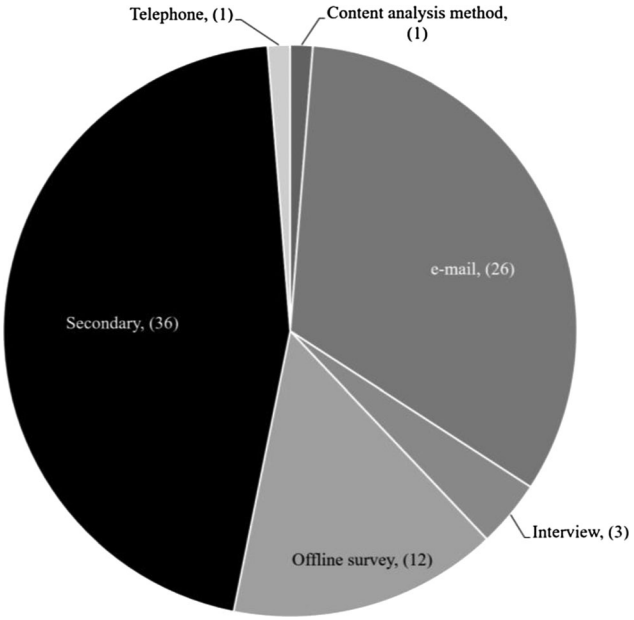


FIGURE 8 Graphical representation of the data collection techniques used in the selected green process innovation studies

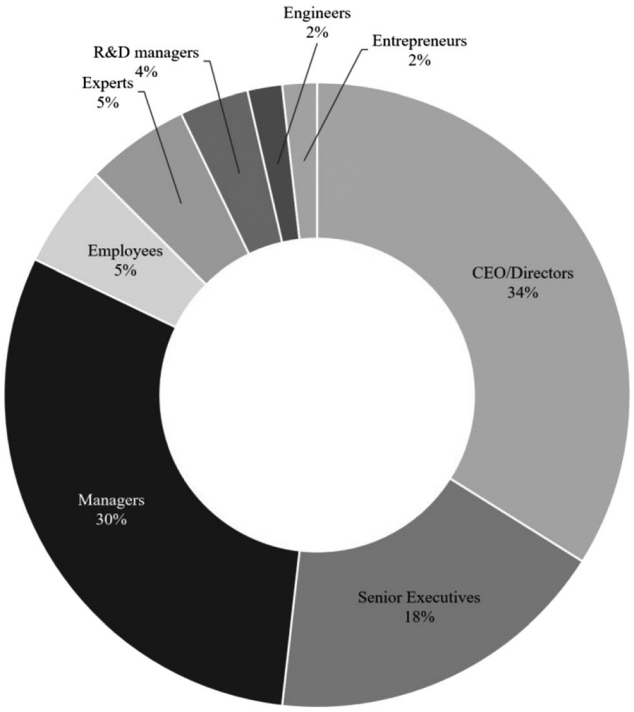


FIGURE 9 Graphical representation of the respondent profiles extracted from the selected green process innovation studies

We then followed a three-step procedure to minimise the bias associated with the thematic segregation of studies. First, two authors of this study conducted the open coding of the selected studies using the Microsoft Excel 2019 program. In the second step, inductive and deductive reasoning were utilised to conduct axial coding to identify relationships among the open codes. In the third step, we requested a professor and a practitioner with experience in green innovation-related topics to review the themes identified in the second step. The experts were largely in agreement with the developed themes, which suggests that the researchers had rigorously discussed the open and axial coding-related issues. However, based on the feedback received from the experts, some minor corrections were made, and a total of seven themes were finalised (see Figure 11). The developed themes were strategic response, organisational learning, institutional pressures, barriers, structural issues, outcomes and reflections on the methodological choices adopted by the selected studies of this review.

4.1 | Strategic response

In the ever-changing business landscape, firms must employ different strategic responses to survive. Strategic responses refer to the decisions taken by firms to align their operations to the external environment (Johnson et al., 2005). These responses are broadly classified into reactive and proactive responses (Aragón-Correa, 2000). Firms with a reactive response tend merely to comply with compulsory requirements and delay action until the very end of the process (Haque et al., 2016), as the formalisation of environmental objectives has not yet been defined and integrated into the overall business strategy (Perego & Hartmann, 2009). However, firms that follow a more proactive response voluntarily take up environmentally friendly practices and even exceed the minimum regulatory compliances (Torugsa et al., 2013). The prior literature on GPcI has studied five different types of strategic responses, which include environmental orientation, environmental ethics, technological implementation, environmental corporate social responsibility (ECSR) and political connections, as discussed below.

4.1.1 | Environmental orientation

Environmental orientation refers to the managerial recognition of the environmental problems surrounding the firm (Banerjee, 2002). Embodied in the mission statement of the firm, environmental orientation is often segregated into internal and external orientations. Internal orientation concerns the values and norms of the firm, which researchers deem to be a kind of pro-environmental culture that shapes the strategic vision of the firm and motivates the employees to think in more environmentally friendly ways (Gabler et al., 2015). External orientation, meanwhile, refers to the attitude of the firm towards environmental conservation (Banerjee, 2002). Such an orientation is shaped by the pressures from various stakeholders by way of regulations and other norms, which force the firm to switch to GPcI (Chan, 2010). Together, internal and external orientations influence the relationship of the firm with its various stakeholders and, as such, play a crucial part in pushing the firm to adopt GPcI (L. Feng et al., 2018).

Note: Journal with citations in the range of '0-8' include Applied Energy, Natural Hazards, Sustainable Development, Science of the Total Environment, International Journal of Innovation Management, Journal of Business & Industrial Marketing, Sustainable Production and Consumption, Asia Pacific Journal of Management, International Journal of Production Research, Journal of Manufacturing Technology Management, Technology in Society, Journal of Environmental Management, Mathematics.

FIGURE 10 Graphical representation of the number of citations received by selected studies in different journals

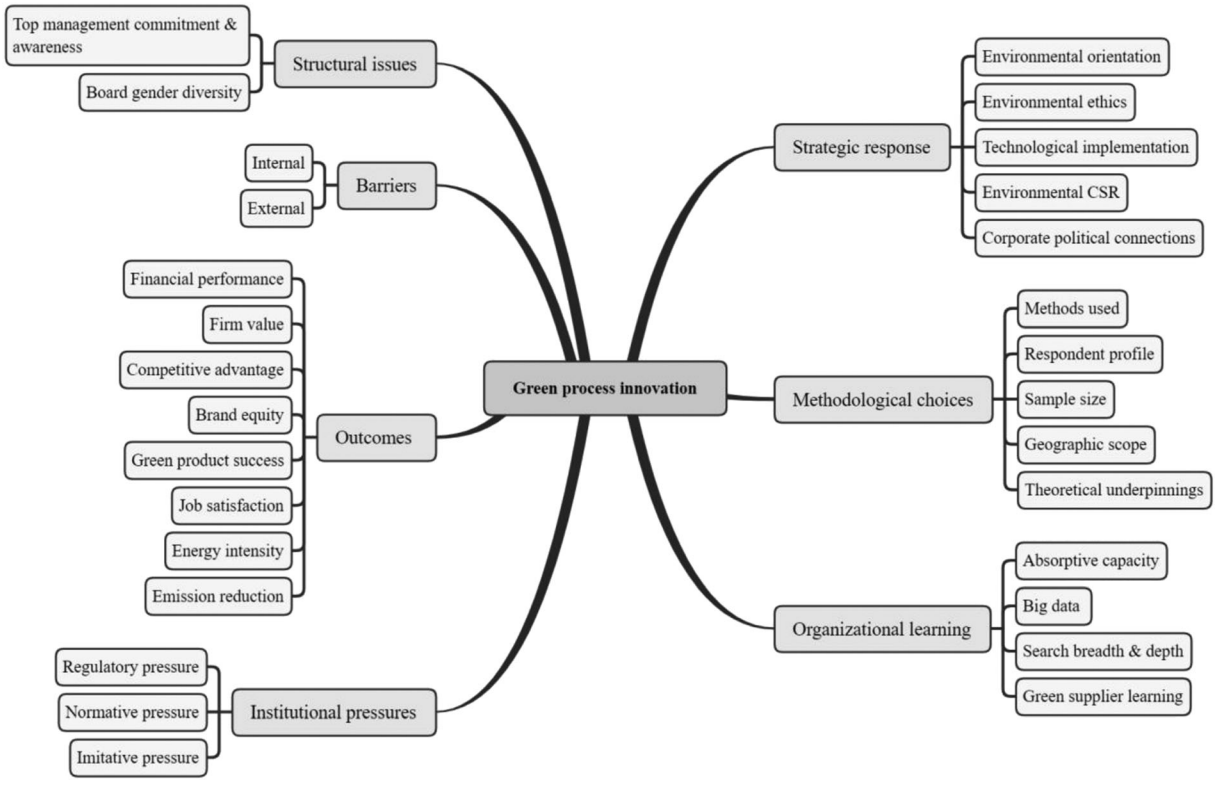


FIGURE 11 Thematic foci of the studies

4.1.2 | Environmental ethics

Environmental ethics refer to the integration and formalisation of environmental beliefs into decision-making (Guo et al., 2020). Firms with high environmental ethics are concerned about the degradation of the environment, which prompts them to place greater emphasis on the greening of their production processes (Chang, 2011). Environmental ethics influence the innovation of environmentally friendly technology and operations, which, in turn, results in a competitive advantage for the firm (Schlegelmilch et al., 1996). Therefore, if firms want to enhance their competitive advantage through the development of GPcI, they should invest heavily in raising their environmental ethics (Chang, 2011).

4.1.3 | Technological implementation

Firms are implementing advanced manufacturing technologies (AMTs), which mostly comprise factory automation technologies (Swink & Nair, 2007), to enhance their information sharing and processing capabilities, which, subsequently, has a positive impact on GPcI. AMTs allow the employees to interact more efficiently while facilitating real-time information sharing within the firm (Zairi, 1992). This swift communication and information flow results in improved coordination across departments, thereby enhancing the GPcI capabilities of the firm, especially during the initial phases of development (Turkulainen & Ketokivi, 2012). Similarly, AMTs bring automation and computational capabilities together. This synergetic effect then helps in the optimisation of resource utilisation, which, in turn, helps the firm meet environmental regulations (Kong et al., 2016).

4.1.4 | Environmental corporate social responsibility

ECSR refers to the responsibility of the firm for its impact on society (European Commission, 2011). ECSR helps generate slack resources in addition to the resources possessed by the firm. Slack resources reduce the risks and uncertainties inherent in the implementation of GPcI projects (Teece et al., 2016) and, therefore, have become more or less necessary to derive benefits from such innovations (Chiu et al., 2008). Firms that are non-innovative due to financial constraints may be aided through ECSR activities as slack resources can be invested in R&D activities that can then help produce GPcI (Zúñiga-Vicente et al., 2014). The relevant literature on GPcI has identified four main sources of financial slack, including, first, cost savings on the part of fewer material inputs (Aragón-Correa, 1998); second, higher profits due to deductions in taxation and other related subsidies (Forcadell et al., 2021); third, attracting new customers (Choi & La, 2013); and, finally, access to additional funding from investors (Harjoto & Jo, 2015). Therefore, ECSR not only generates a cost advantage and tax rebates for the firm but also attracts additional investments as the overall profitability increases due to the inclusion of new green customers in its total portfolio (Forcadell et al., 2021).

4.1.5 | Corporate political connections

Corporate political connections refer to close relationships with politicians and government officials (Nee & Opper, 2010). Political capital is beneficial for the firms as it extends preferential treatment, taxation benefits and lower regulatory pressures and other beneficial resources (Faccio, 2010). As firms are compelled to adhere to certain regulations, they tend to use their political connections to seek government protection and access to resources that can help the firm sustain its competitive edge over rivals (H. Wang & Qian, 2011). Political capital also has a positive impact on the R&D activities of the firm (Khwaja & Mian, 2005). Furthermore, firms that are politically well connected have better GPcI than non-connected firms, which may be explained by the mitigation of risks due to political capital (Nanda & Rhodes-Kropf, 2013).

4.2 | Organisational learning

Firms are increasingly looking at new knowledge sources while refining their existing knowledge to compete with their rivals and comply with the regulations set forth by different governmental and non-governmental agencies. Firms these days acquire new knowledge by entering into strategic partnerships with alliance partners and suppliers (Manuj et al., 2014). Moreover, the use of Big Data techniques is becoming increasingly popular among firms as it offers rich insights into data (Tien, 2013). The extant literature on GPcI has broadly focused on four issues related to organisations learning. These include absorptive capacity, Big Data, search breadth and depth, and green supplier learning (GSL), which we discuss below.

4.2.1 | Absorptive capacity

A firm's absorptive capacity is its ability to value and assimilate new information and exploit it for commercial ends (Cohen & Levinthal, 1990). Green absorptive capacity plays a crucial role in recognising the external pressures and understanding the mechanisms that can help overcome organisational inertia (Pacheco et al., 2018). Likewise, absorptive capacity helps in the inter-functional coordination required to assimilate and apply knowledge (Najafi-Tavani et al., 2016). Under high environmental pressures, firms tend to focus on developing intrinsic capabilities so that they can succeed with their GPcI efforts (Lin et al., 2016). As one of the crucial firm-specific capabilities, absorptive capacity instigates the realisation of inter-organisational learning. However, the firms' response by way of GPcI relies heavily on their assimilation of supply-side technological and demand-side customer preferences (Brix, 2019). Firms that do not

possess the right mix of absorptive capacity are more likely to resist institutional pressures, whereas those that possess higher absorptive capacity are more likely to see the environmental pressures as opportunities and turn them into a competitive advantage (Delmas et al., 2011). Absorptive capacity helps the firm to integrate such pressures into green innovation practices and, therefore, positively influences the development of GPcI (Ben Arfi et al., 2018).

4.2.2 | Big Data

Big Data refers to large volumes of datasets (Hampton et al., 2013) that require special acquisition and application skills to extract meaningful information from them (Tien, 2013). Over the years, data collection and storage capacities, along with the available volumes of data, have increased exponentially, and, as such, traditional methods of drawing meaningful analysis from data have become redundant (Li et al., 2016). Big Data offers access to new information, which can help in decision-making processes (Tien, 2013), but it also requires a significant change in the existing organisational capabilities to utilise it (Braganza et al., 2017). The implementation of Big Data Analytics has created a challenge for the traditional theories and methods of environmental evaluation despite its inaccuracies and imperfections (M. L. Song et al., 2018). Big Data Analytics has a marginally positive impact on firms' GPcI efforts and, consequently, their performance as well (El-Kassar & Singh, 2019).

4.2.3 | Search breadth and depth

The manner in which firms search for external knowledge has been broadly segregated into search breadth and search depth. Search breadth refers to the number of sources that a firm uses in its innovation process (Laursen & Salter, 2006). Firms tend to have a trial-and-error period in which they decide on the number of external partners and channels necessary for improving their innovation capacity. Such diversification helps the firm hedge against the various risks associated with the innovation search (Leiponen & Helfat, 2010) and helps them find a viable combination. Horbach et al. (2013) argued that firms' pursuits of GPcI require more external knowledge sources than other innovations, as the knowledge is heterogeneous and dispersed among various partners. Therefore, the higher the number of external sources is, the better the chances of finding and developing GPcI will be.

Search depth, on the other hand, refers to the extent to which firms extract knowledge from different search channels and sources (Laursen & Salter, 2006). As the firm finds a suitable external source or channel, it tends to benefit from it due to the lower transaction costs associated with the deep assimilation of knowledge (Greco et al., 2016). Search depth has a positive impact on the GPcI effort of firms because it facilitates a greater resource and knowledge flow to take place. Increasing the magnitude and frequency of interactive learning helps the firm reap advanced knowledge; therefore, the possibility of switching to GPcI increases significantly (González-Moreno et al., 2019).

4.2.4 | Green supplier learning

Learning from green suppliers includes acquiring information pertaining to environmental protection and developing the skills and capabilities required to tackle environmental issues (Fang & Zou, 2010). GSL pushes the firm to align its manufacturing technology to suit the advanced materials, components and services provided by suppliers (Fang & Zou, 2010). Furthermore, GSL helps in developing shared norms and goals for both the manufacturing firm and the supplier, which, in turn, strengthens both parties' green project implementations. GSL allows the manufacturing firm to focus on GPcI, such as by installing green equipment and pollution control systems to demonstrate its commitment to shared environmental goals (T. Feng et al., 2016). However, the impact of GSL on GPcI adoption is conditional to the level of technological turbulence surrounding the firm. Firms operating in highly turbulent environments and constrained by slack resources are likely to focus on external technological demands (M. Song et al., 2005).

4.3 | Institutional pressures

The institutional theory posits that firms operate under different regulatory norms and governing bodies (e.g., governmental agencies, non-governmental organisations, media and other rights groups; Bansal & Clelland, 2004; Campbell, 2007) that collectively govern their actions. The relevant GPcI literature has studied and discussed three institutional pressures, which include regulatory, normative and imitative pressures.

4.3.1 | Regulatory pressure

Regulatory pressures, also referred to as command and control regulations, are rules that govern the behaviour of firms in an economy (Prajogo et al., 2012). Command and control regulations mandate that all firms adhere to environmental responsibilities while disregarding the cost differentials that exist between them. Such regulations affect market access, product and emissions standards and other production technologies, to name a few. Any disregard for these regulations may expose the firm to administrative punishments and a more stringent inspection procedure (Shen et al., 2020). In the absence of environmental regulations, manufacturing firms tend to avoid GPcI efforts. Coercive regulatory measures thus act as deterrents and eventually force the firm to take up green technological innovations or end-of-pipe innovations (M. Wang et al., 2020). However, regulatory policies are not enough on their own as much depends on the proper implementation of such pressures by the various governmental agencies as well as the willingness of the officials to enforce these regulations (Eltayeb et al., 2011).

4.3.2 | Normative pressure

Pressures from customers and non-governmental agencies, termed normative pressures, prescribe appropriate environmental behaviours for the firm based on societal norms and values (Berrone et al., 2013). As such, firms are increasingly taking up GPcI in an effort to cater to the environmental-centred demands of the customers (Huang et al., 2016). Likewise, the local community and investors also assess the environmental legitimacy of firms (Bansal & Clelland, 2004), with the media also playing a greater role in this awareness (X. Chen et al., 2018). As firms acquire and/or develop GPcI, they signal to the customers their willingness and commitment to environmental conservation (Wittstruck & Teuteberg, 2012). The subsequent adaptation of manufacturing processes helps minimise the long-term detrimental effects on the environment due to the firms' production process and, in turn, fosters increased cooperation and support from customers (Chiou et al., 2011).

4.3.3 | Imitative pressure

Imitative pressures originate from the firm's peers and influence the firm's GPcI strategies. As firms increasingly seek to adopt GPcI, they compel other firms operating in similar industries to adopt the same kinds of measures (Carter & Rogers, 2008). When firms lack strategic direction, they tend to imitate the strategic behaviour of their peers (DiMaggio & Powell, 1983), which eventually helps them reduce the risks associated with their decisions. In fact, the most common reason advanced by researchers for the non-adoption of GPcI is the uncertainty associated with such endeavours (Rennings & Rammer, 2011). As the number of firms adopting GPcI increases, this uncertainty decreases as a result, and a network of green firms emerges, which further creates barriers for the non-green firms and affects their competitiveness (Qi et al., 2021).

4.4 | Structural issues

Structural issues pertain to the overall hierarchical structure, leadership, culture, roles and skills of employees in a firm (Vial, 2019). Firms usually make changes to their structures to shape or support their strategies (Matt et al., 2015). The relevant literature on GPcI has revealed two major structural issues that warrant the attention of firms, namely, top managerial commitment and awareness and board gender diversity, which are discussed below.

4.4.1 | Top managerial commitment and awareness

The awareness and commitment of top management towards environmental issues is a crucial factor in deciding the strategic path that firms will choose while doing business. The GPcI literature broadly categorises managers' environmental awareness into environmental risk awareness and environmental cost–benefit awareness (Gadenne et al., 2009). Environmental risk awareness refers to the firm's cognisance of its negative impacts on the environment, whereas environmental cost–benefit awareness is the cost advantage that the firm can achieve as a result of eco-friendly innovations (Peng & Liu, 2016). Both managerial risk awareness and cost–benefit awareness play a positive role in the GPcI process as they allow the managers to focus on environmental issues and create business opportunities while addressing such concerns. Moreover, managers with higher environmental risk awareness tend to choose GPcI, which has the potential to exceed emission targets well-above the thresholds set by regulatory bodies (Liu et al., 2015).

Commitment, on the other hand, signifies the firm's dedication to upholding a relationship and enables the achievement of mutual goals. The commitment towards green innovations can not only strengthen ecological performance but also enhance cooperation from customers, thereby resulting in higher firm performance (Burki et al., 2018). Top managerial backing is essential for successful environmental management as it plays a crucial role in the adoption and implementation of GPcI (Kearns & Sabherwal, 2006). Furthermore, environmental commitment helps in the refinement of operational and managerial performance, which then translates into a competitive advantage for the firm (Lee, 2009).

4.4.2 | Board gender diversity

Women tend to have stronger environmental preferences than men, which makes their presence on management boards a significant predictor of a firm's environmental actions (He & Jiang, 2019). This generally heightened environmental sensitivity often leads women to comply properly with all ethical codes of conduct (Ibrahim et al., 2009) and stimulate environmentally healthy strategies in the firm (Nadeem et al., 2017). Moreover, women's participation in boards tends to stimulate dialogue and discussions centred around stakeholders' needs via the more participative and democratic leadership style that they tend to cultivate. Therefore, the presence and participation of women in boards enrich the diversity of opinions therein and, as such, help the firm make strategic changes in its operations to suit the environmental needs (Adams & Ferreira, 2009). Indeed, researchers have contended that heterogeneous boards are more likely to make better decisions and offer innovative solutions. The inclusion of women on boards represents different stakeholders' needs, thereby adding to this heterogeneity and ensuring that the strategic changes required in the processes of the firm are not ignored (He & Jiang, 2019).

4.5 | Outcomes

Firms adopt GPcI either voluntarily or due to different institutional pressures. Once adopted, however, GPcI generates different performance implications. While synthesising the relevant literature on

GPcI, we came across eight different performance outcomes, which include financial performance, brand equity, job satisfaction, competitive advantage, green product success, firm value, energy intensity and emission reduction.

4.5.1 | Financial performance

The adoption of any new technology has performance implications for the firm, and GPcI is no exception. The extant literature has categorised GPcI as consisting of either clean technology or end-of-pipe technologies, both of which have different implications for the firm (Xie et al., 2016). Clean technologies help in the minimisation and elimination of wastage and other pollutions in the production process. Although investing in clean technologies requires heavy funding, it does reduce the costs of environmental compliance and improve the long-run performance of the firm (Chien & Peng, 2012). Furthermore, clean technology adoption not only reduces harmful environmental impacts but also enhances the performance of the firm by way of cost, speed and flexibility of operations (Klassen & Whybark, 1999).

End-of-pipe technologies, on the other hand, are process technologies that treat pollution at the end of the production process and turn the emissions into manageable substances (del Río González, 2005). End-of-pipe technologies have the potential to address regulatory concerns and mitigate the negative effects of production processes on the environment (Frondel et al., 2007). Adopting such technologies has fewer barriers as they usually require fewer adjustments in the existing production processes and technologies possessed by the firm (del Río González, 2005). Moreover, end-of-pipe technologies can prove beneficial for the firm in terms of the resource rarity that such technologies offer, as these can add value by way of economic rent to the firm (Hart, 1995). Thus, the adoption of both clean technologies and end-of-process technologies are beneficial not only to the environment but also to the firm as they help in the generation of higher profits and slack resources.

4.5.2 | Firm value

Firm value refers to the net present value of the future cash flows that a firm may generate (Rao et al., 2004). In emerging economies, customers often do not appreciate the firms' green efforts and are less willing to prefer products made through GPcI. The reason for such a tendency is partly explained by the lack of proper awareness among customers about environmental issues as well as by their inability to pay higher prices for products made through such processes (Zhu & Sarkis, 2016). However, firms are also responsible for this to some extent if they are unwilling to commit huge funds to GPcI, which overburdens their balance sheets and reduces their profit margins (Rennings & Rammer, 2011). However, stringent environmental regulations can alter the negative value implications of GPcI through subsidies, monetary incentives and favourable policies for environmentally friendly production (Yao et al., 2019).

4.5.3 | Competitive advantage

Adopting GPcI also improves a firm's competitive edge against its rivals (Chang, 2011). Firms investing in clean and end-of-pipe technologies minimise the wastage of resources and improve their productivity, which, in turn, enhances their image in the market (Berry & Rondinelli, 1998). As firms successfully improve their image, they not only strengthen the customer adoption of products and services but also extend the first-mover advantage to themselves, thereby giving them an edge over rival firms (Chang, 2011; Y. S. Chen et al., 2006).

4.5.4 | Brand equity

Brand equity refers to the additional value that a firm extracts from its products due to its brand name, which results in part from customers' awareness about the brand, its strength and uniqueness, as well as its likeability and the customers' experiences with it (Keller, 1993). As firms adopt green innovation strategies, they send a positive signal to customers that allows them to charge higher prices or gain an early-mover advantage in new market segments. These strategies further enable the firm to create strong brand associations and a loyal customer base (Porter & van der Linde, 2017). Accordingly, firms should focus on highlighting the environmental and economic benefits of GPcI in their communications to reap the optimum benefits of brand equity (Amores-Salvadó et al., 2014). However, GPcI is less visible to customers than green product innovations, which is why customers do not always appreciate the firms' efforts to reduce pollution in their production processes. Empirical studies have found that customers are unwilling to bear the extra green energy costs because such measures are a part of the production (Kammerer, 2009). Therefore, such efforts are less likely to create brand equity for the firm (Hillman & Keim, 2001).

4.5.5 | Green product success

Firms are increasingly turning to GPcI partly because of increasing customer awareness about environmental issues (Banerjee et al., 2003). However, addressing such concerns effectively and succeeding at the same time is a daunting task that requires a thorough understanding of both customer and regulatory requirements and environmental ethics (V. Wong et al., 1996). The reduction of resource wastage, cutting down of emissions, reuse of materials and components, and efficient use of energy in the production processes lead to the production of green products, which customers are increasingly demanding (S. K. S. Wong, 2012).

4.5.6 | Job satisfaction

Job satisfaction refers to the employees' evaluation of the conditions present in the job or the benefits that they may obtain from

it. Employee satisfaction is essential for the firm as low satisfaction can create a spike in the turnover level, which translates into poor business performance (Iranmanesh et al., 2017). As GPcI warrants the minimisation of pollution, recycling of waste and reuse of materials and components, it requires a unique skill set to achieve this properly (Santamaría et al., 2012). Firms lacking such skilled employees may become burdened with schedules and tasks, which put pressure on their existing workforce and, in turn, create job dissatisfaction (Bohle et al., 2011). Furthermore, as different training programmes are frequently scheduled to enhance the skills required for GPcI, the resultant increase in job intensity drives a higher turnover rate (Loch, 1998).

4.5.7 | Energy intensity

Energy intensity may be defined as the inefficient use of energy in an economy. Major emerging economies like China have struggled to reduce energy intensity over the past few decades. Energy intensity not only puts higher pressures on economic resources but also traps the country in environmental pollution (Fan et al., 2007). As GPcI consumes less energy, it translates into fewer energy costs and higher profits for the firm (Yan et al., 2021). The use of GPcI thus has the potential to increase energy efficiency in an economy while reducing the total energy requirements, thereby leading to increased savings (Y. Chen et al., 2016).

4.5.8 | Emission reduction

Given that the burning of coal and oil and environmental pollution have worsened, and emission levels have reached an all-time high, there are increasing calls worldwide for firms to switch to GPcI so that the environment can be protected from disasters (Du et al., 2019). Green technologies can effectively cut down emission levels, reduce pollution and improve our ecology (Y. J. Zhang, Peng, et al., 2017). However, the adoption of such technologies is a daunting task for any economy. In addition, it requires serious policy-making and regulatory efforts by the governments both within and across borders.

4.6 | Barriers

GPcI barriers may be defined as the absence of factors required for innovation. The relevant literature has revealed various internal and external factors that act as barriers in the firm's transition to GPcI. *Internal barriers* are inherent in the firm and include high developmental costs, lack of qualified staff (Consoli et al., 2016), limited management capacity (Noci & Verganti, 1999), large technological gaps (Stucki & Woerter, 2017), a lack of financing (Ghisetti et al., 2017) and a lack of favourable attitude and perception towards innovation in green products (Abdullah et al., 2016). The various *external barriers* that hamper the adoption of GPcI include low willingness to pay (Hall & Helmers, 2013), high commercial uncertainty (Stucki & Woerter, 2019), downward price trends (Agarwal & Bayus, 2002), lack of government support (Popp et al., 2010) and poor external partnerships (Hadjimanolis, 1999).

As GPcI requires firms to be innovative, a lack of proper communication mechanisms, poor normative practices, inappropriate human resource practices and lack of commitment from top executives drive employee resistance to such innovations (Zwick, 2002). Therefore, the firms' decision-making bodies are required to make significant changes in their operations, be open to new ideas and allow their employees to try new creative ideas (Williander, 2006). Likewise, a lack of information about market and technological trends also constrains the firms' GPcI adoption. While combating environmental pollution through the reduction in greenhouse gas emissions has become necessary, finding the right technologies that address these changing environmental regulations is challenging for the average firm (Woolman & Veshagh, 2006). Similarly, the lack of adequate customer demand also acts as a barrier to the adoption of GPcI. Firms indulging in green innovations witness low levels of customer demand due to the higher cost of their product offerings. This tendency keeps the firms away from adopting GPcI as such projects require huge capital investments, and profitable returns from such projects take years (Abdullah et al., 2016).

4.7 | Methodological choices

The major focus of the selected studies was to examine the impact of different factors on the adoption of GPcI in firms and the consequences of such adoption. Towards this end, the studies have utilised different methods and techniques and engaged various stakeholders. The discussion, therefore, in this theme will centre around the methods used, the respondents' profile, the sample size, the geographical scope and the theoretical underpinnings.

Methods used

The majority of the studies in this review have tested their hypothesis using primary data, including e-mail surveys (Albort-Morant et al., 2018), face-to-face interviews (F. Zhang & Zhu, 2019), telephone interviews (Kong et al., 2020) and offline surveys (e.g., Cai et al., 2020). Although primary data collection methods help to validate theories, such methods often suffer from social desirability bias and, as such, cast doubt on the generalisability of such findings. Although a sizeable number of studies also utilised secondary databases, the scope of these is primarily restricted to Chinese samples, thereby necessitating a revalidation in other contexts.

Respondent profile

Most of the studies have collected data from top-level executives, which include CEO/directors (e.g., Burki & Dahlstrom, 2017), senior executives (e.g., Afshar Jahanshahi et al., 2020) and other managers (e.g., Y. S. Chen et al., 2006). Although these respondent groups are well versed with the firm-level issues pertaining to GPcI, the insights

and concerns of the lower level managers and other support cannot be neglected.

Sample size

The studies on GPcI have mostly extracted their results on samples below 250 respondents, making it problematic to generalise their results.

Geographic scope

The studies included in this review have mostly focused on China, which highlights the need for similar studies in other contexts and geographies.

Theoretical underpinnings

As evidenced in Figure 6, the selected studies on GPcI have used stakeholder theory, the RBV and institutional theory to understand the various issues and challenges of GPcI. Although these studies offer unique insights into GPcI-related issues, there is a need to utilise other theoretical lenses like organisational learning theories, ambidexterity theory, dynamic capabilities theory, networking and other emerging theories to unveil the challenges and driving factors of GPcI.

5 | RESEARCH GAPS AND POTENTIAL RQs

Our critical analysis of the extracted themes as well as the research profile of the studies led us to highlight the different gaps in the GPcI literature, which are provided against the various subthemes of this review. These gaps, provided in Table 1, can provide a pathway for future researchers to undertake further research on GPcI, which, in turn, can broaden our understanding of the topic while aid managerial decision-making.

6 | FRAMEWORK DEVELOPMENT

The content analysis of the studies included in this SLR helped us identify the common strands in the GPcI literature and the various gaps warranting further research investigations. This deep understanding of the GPcI research has allowed us to use inductive logic to form a systems framework for our study (see Figure 12). Proposed by Katz and Kahn (1966), the systems framework includes an input–process–output–feedback cycle and the influence of external pressures. According to this theory, the firm processes the inputs into an output and regularly checks if the output is as planned before making any changes to the inputs accordingly. The whole exercise of converting inputs into outputs is largely influenced by external environmental changes. In this study, we utilise the systems theory to build our framework, which we call the 'green process innovation model', which includes (a) institutional pressures, (b) inputs, (c) strategic responses, (d) organisational learning, (e) transformative processes and (f) outcomes.

We first conceptualise GPcI adoption as triggered or influenced by outside *institutional pressures*, which include regulatory forces, normative pressures and imitative pressures. Regulatory pressures are considered coercive measures because they push the firms to adopt regulations or face monetary and non-monetary punishments. Similarly, customers, media and other NGOs also pressure firms to adopt certain environmental norms, while the firm may voluntarily adopt certain practices under imitative pressures. Collectively, all of these different institutional forces are effective in triggering changes in the behaviours and routines of the firm.

Inputs consist of transformational leadership, organisational culture, green human resource management, managerial awareness and board gender diversity, which represent the various decisions of the firm that have a bearing on the overall production choices, learning programmes, ethical practices and environmental responsiveness. The decisions taken at this stage highlight the overall focus of the firm and, as such, have a significant impact on its strategic responses and organisational learning, which, in turn, influence the transformative processes. For instance, the inclusion of men and women with diverse backgrounds and experiences will reinforce a wide range of acceptable behaviours at the top management team level. A more diverse board will also discuss and take forward different pro-environmental ideas and also reshape the ways that the firm does business.

The transformative process results in the firm adopting green technologies, end-of-pipe processes or both. The effective adoption and implementation of such processes are dependent on the learning orientation and strategic response of the firm. Organisational learning includes absorptive capacity, Big Data Analytics, search breadth and depth, and supplier learning. GPcI requires firms to acquire new knowledge. Accordingly, firms usually enter into learning agreements with partner or supplier firms while working on enhancing their capabilities to exploit and absorb their existing knowledge and Big Data. The strategic response, meanwhile, includes environmental orientation, ethics, ECSR, political connections and technological implementation. Strategic responses represent the actions of the firm in response to external pressures. These responses are adopted to build and sustain the firm's competitive edge, which positively influences their adoption of GPcI. Both learning and strategic responses go hand in hand, as strategic responses need up-to-date knowledge of different aspects of GPcI and vice versa.

The *output* of transformative processes includes firm performance, firm value, competitive edge, brand equity, green product success, job satisfaction, energy intensity and emission reduction. The successful implementation of the firm's learning programmes and its pro-environmental strategic responses will have a positive impact on the adoption of GPcI and, in turn, will result in a positive influence on the performance implications of such decisions.

The output, in terms of various performance targets, acts as *feedback* to the management, who then compares such outputs to their targeted performance. This feedback then helps them in revising their learning programmes and other strategic decisions.

TABLE 1 Theme-based research gaps and potential research questions

Themes	Subthemes	Gaps	Potential RQs
Strategic response	Environmental orientation	• Researchers have not explored the antecedents to environmental orientation. • The factors that may moderate the impact of environmental orientation on GPcI have not been studied.	RQ1.1. What are the various antecedents to environmental orientation? RQ1.2. Which moderating factors can enhance or inhibit the influence of environmental orientation on GPcI? RQ1.3. How can firms strike a balance between internal and external orientations?
	Environmental ethics	• A limited number of studies have been conducted on the ethical and unethical practices of firms. • Factors that enhance or inhibit the environmentally ethical practices of firms have not been studied.	RQ1.4. What drives corporate environmentally unethical practices? RQ1.5. How can incumbent firms modify and enhance their environmentally ethical practices?
	Technological implementation	• There is a lack of studies on the capabilities required for the successful implementation of different technologies. • Researchers have not studied the conditional impact of different external factors on technological implementation.	RQ1.6. What internal capabilities are required by firms for the smooth adoption and implementation of advanced technologies? RQ1.7. Under what conditions are the implementation of advanced technological systems seen as unfruitful?
	Environmental CSR	• The research on ECSR activities is under-explored.	RQ1.8. What factors enhance the green ECSR tendencies of firms? RQ1.9. At what time do ECSR activities help the firm generate higher profits as a result of attracting environmentally conscious customers? RQ1.10. Can firms still fail to generate slack resources despite high ECSR investments?
	Political connections	• There is a paucity of research on the impact of political ties on GPcI. • As most of the studies have been conducted in China, the manner in which firms sustain their ties in democratic settings have not been explored. • As emerging economies are riddled with red tape and corrupt practices, there is a need to understand the impact of such factors on the adoption of GPcI and to look for ways to overcome these challenges.	RQ1.11. What are the various challenges that firms with weak political connections face, especially in developing economies, and how can such challenges be tackled? RQ1.12. How do firms maintain political connections in democratic countries where the ruling party changes after every few years? RQ1.13. Does corruption restrict the adoption of GPcI, and how can such practices be curtailed?
Organisational learning	Absorptive capacity	• There is a limited understanding of the mechanisms, structures and factors that enhance the absorptive capacity of firms. • Factors and organisational routines that enhance or dampen the impact of absorptive capacity on GPcI have not been studied.	RQ2.1. How can firms enhance their absorptive capacity for GPcI? RQ2.2. What are the various moderators that enhance the impact of absorptive capacity on GPcI efforts of firms?
	Big Data	• The role of Big Data, deep learning and artificial intelligence techniques has not been used to gauge customer sentiments and behavioural tendencies.	RQ2.3. In what ways can Big Data, deep learning and artificial intelligence techniques enhance the firm's customer-centric learning?

(Continues)

TABLE 1 (Continued)

Themes	Subthemes	Gaps	Potential RQs
			RQ2.4. When should a firm develop Big Data, AI and deep learning techniques in-house, and when should it outsource?
	Search breadth and depth	• Empirical studies on the antecedents, outcomes and moderating factors to search breadth and search depth are still lacking. • There is a limited understanding of the mechanisms that firms follow to simultaneously pursue search breadth and depth strategies.	RQ2.5. What are the various antecedents and outcomes of green search breadth and depth strategies? RQ2.6. Which factors moderate the impact of search breadth and search depth on GPcI implementation? RQ2.7. How do firms achieve ambidexterity in their pursuit of green search breadth and search depth strategies?
	Green supplier learning	• Previous studies on GPcI have not examined the extent to which suppliers should be involved in the learning process. • The long-term cost–benefit analysis and the risks inherent in collaborations with suppliers for GPcI have not been studied.	RQ2.8. When and to what extent should a firm involve suppliers in the GPcI process? RQ2.9. Are collaborations with suppliers for GPcI profitable for the firm? RQ2.10. What prohibits firms from entering into learning agreements with green suppliers?
Institutional pressures	Regulatory pressure	• Researchers have not explored the factors that help in sustaining the competitive advantage of firms operating in different countries under different regulatory pressures. • The loopholes in cross-country regulatory mechanisms have not been unravelled.	RQ3.1. How can firms operating under coercive pressures consistently create GPcI to enhance their competitive edge over rival firms? RQ3.2. What policy decisions and practices at the policy-making level can curtail corruption at the bureaucratic level and enhance transparent mechanisms to ensure smooth implementation of green regulations? RQ3.3. What policy decisions are needed to inhibit non-green firms from relocating their processes to developing economies to avoid environmental regulations in their home country? RQ3.4. Which regulations can push the firms to adopt or switch to green technologies from end-of-process solutions?
	Normative pressure	• There is a limited understanding of how firms under increasing normative pressure transition to GPcI, especially when they are constrained by resources.	RQ3.5. Under increasing normative pressures, in what ways can a firm secure capital investments while transitioning into GPcI? RQ3.6. What role can the media houses and NGOs play in amplifying normative pressures on firms, especially those operating in emerging economies?
	Imitative pressure	• Researchers are yet to study the impact of imitative pressures on GPcI adoption	RQ3.7. How can a firm offering GPcI sustain its competitive edge in

TABLE 1 (Continued)

Themes	Subthemes	Gaps	Potential RQs
		thoroughly, which limits our understanding of this concept.	the market as the risk of imitation by rivals is high? RQ3.8. Can imitative pressures prove effective in pushing rival firms into a learning trap?
Barriers to GPcI	Internal/external	• Researchers have not explored the factors that can help firms overcome different internal and external barriers to adopting GPcI.	RQ4.1. How can the firm induce the customers to adopt products produced through GPcI when they do not see any immediate added value in such purchases? RQ4.2. Which factors at the policy and firm level can help lower the cost of products and services produced through GPcI? RQ4.3. Which policy decisions are required at the national level to spur innovation into GPcI?
Structural issues	Top managerial commitment and awareness	• There is a paucity of studies on the issues encountered by top management in their pursuit of GPcI.	RQ5.1. How can firms gauge the environmental awareness and commitment level of potential candidates in interviews? RQ5.2. Can the induction of new, environmentally focused CEOs be met with resistance by board members? RQ5.3. What dilemmas do the top management face in their transition from non-green technology to GPcI? RQ5.4. What changes in the board structure and composition are required to create a positive attitude in the firm towards GPcI?
	Board gender diversity	• There is a general lack of studies exploring the various factors that can help in bridging the gender gap at the board level. • More studies are needed to unearth the various challenges that female board members face in their jobs.	RQ5.5. Which policy decisions can prove beneficial in reducing the gender gap at the board level? RQ5.6. Do female board members' voices count? If yes, how often are their opinions and concerns about environmental issues taken seriously?
Outcomes	Firm performance	• There is a paucity of research studies on the performance implications of GPcI.	RQ6.1. Does GPcI pay higher rates of returns? RQ6.2. Do small firms see the adoption of GPcI as an opportunity or a threat to their businesses, especially in emerging market economies?
	Firm value	• As the overall value of the firm depends on the firm's sales and profitability figures, there is a lack of research studies examining the policy factors that can influence the production practices of firms operating in a particular economy.	RQ6.3. How can firms, engaged in GPcI, lobby for stricter environmental regulations? RQ6.4. Can governmental tax subsidies help in adding value to the firms engaged in GPcI? RQ6.5. Which channels and mediums of communication should the firm follow to engage customers to purchase green?
	Competitive advantage	• Research studies are required to examine the ways in which firms sustain	RQ6.6. How can incumbent firms engaged in non-green

(Continues)

TABLE 1 (Continued)

Themes	Subthemes	Gaps	Potential RQs
		their competitive advantage as they switch to GPcI.	innovations sustain their competitive advantage while switching to GPcI? RQ6.7. In cost-conscious markets, how do green firms sustain their competitive edge over rival firms?
	Brand equity	• More studies are needed to understand the cognitive, social and economic factors that influence the brand equity of green firms.	RQ6.8. Which factors influence the brand equity of firms offering products made from clean technology most?
	Green product success	• Researchers have not examined the impact of environmental factors on the product success of firms?	RQ6.9. What impact does environmental uncertainty have on the success of green products?
	Job satisfaction	• Factors that reduce the intensity of jobs and improve the satisfaction of employees working in green firms have not been explored.	RQ6.10. What factors positively influence the job intensity and job satisfaction of employees working in green firms?
	Energy intensity	• Researchers have not studied the impact of green technologies and end-of-pipe technologies separately.	RQ6.11. How energy efficient are green technologies compared with end-of-pipe technologies? RQ6.12. In terms of aggregate cost, is investing in green technologies a better strategy?
	Emission reduction	• The understanding of the various factors that influence the adoption of green technologies is limited.	RQ6.13. How efficient are end-of-pipe technological methods in cutting down the emission levels? RQ6.14. Which factors can enable or inhibit the firms from switching from end-of-pipe technologies to green technologies?
Methodological choices		• Most of the studies on GPcI have surveyed senior management, whereas junior employees, customers, rights groups, NGOs and media agencies have been ignored. • There is a tendency among green researchers to use data from small samples, which may lead to faulty generalisations. • Researchers have mostly focused on China, whereas developed countries and other emerging economies like India and Bangladesh have been ignored. • Most of the studies have utilised stakeholder theory, resource-based view and institutional theory.	RQ7.1. What unique insights can be added to the GPcI literature by the inclusion of junior employees, customers, rights groups, NGOs and media agencies in the study sample? RQ7.2. How reliable are the findings of GPcI studies extracted from small sample surveys? RQ7.3. Are research findings on GPcI context specific, or can they be generalised? RQ7.4. While switching to GPcI, what unique challenges do firms face in other emerging economies? RQ7.5. What unique GPcI strategies have been adopted in emerging markets that the rest of the world can learn from? RQ7.6. How can learning, dynamic capabilities theory and networking theories be used to broaden the understanding of GPcI-related matters?

Abbreviations: AI, artificial intelligence; CSR, corporate social responsibility; ECSR, environmental corporate social responsibility; GPcI, green process innovation; RQs, research questions.

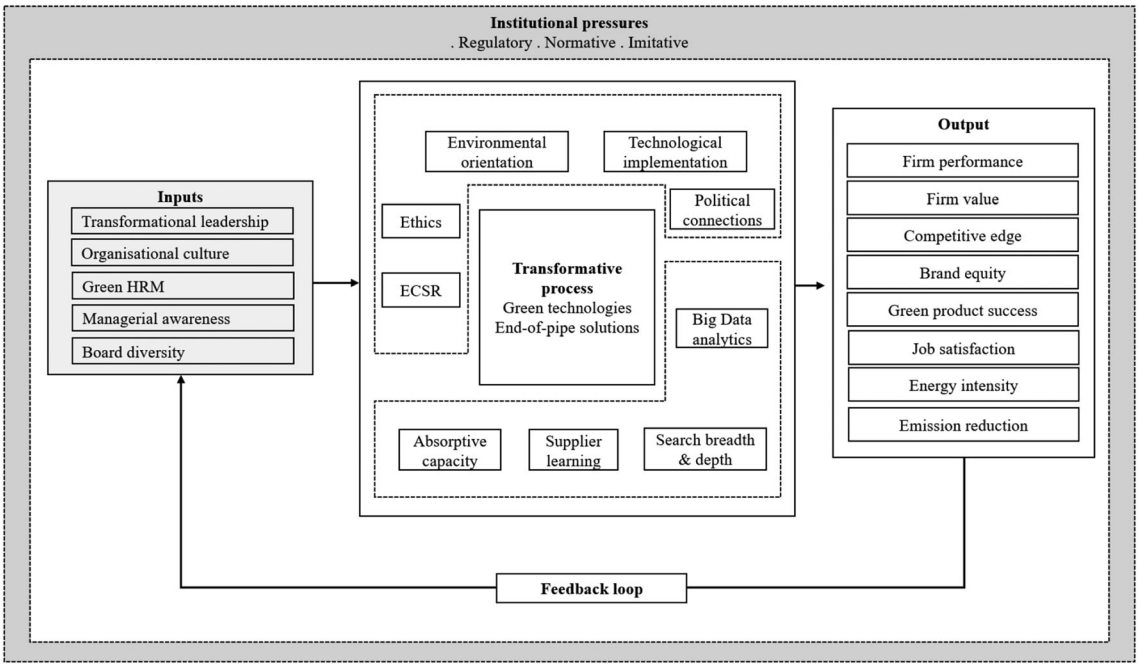


FIGURE 12 Green process innovation model. ECSR, environmental corporate social responsibility; HRM, human resource management

7 | CONCLUSION

The current SLR study makes a multifaceted contribution to the GPcI literature by critically examining the studies published on the topic. First, this SLR study untangles the published literature on GPcI and organises it according to the year of publication, journal-wise distribution, theoretical underpinnings, methods used, sampling techniques, respondent profile and country-wise distribution of the geographies studied. The second contribution lies in the segregation and meticulous analysis of the extracted themes, which further helped us identify the gaps in the GPcI literature. The key themes included (a) strategic response, (b) organisational learning, (c) institutional pressures, (d) structural issues, (e) outcomes, (f) barriers and (g) methodological choices. These themes highlight the strategic response of firms to the changing dynamics and institutional pressures, the role of various learning-related activities in this transition, the structural issues that firms should focus on and the various barriers that inhibit the firms from switching to GPcI. Furthermore, this study, in addition to developing a research framework, also highlights the various gaps in the GPcI literature and the potential RQs that warrant further investigation by researchers.

7.1 | Theoretical implications

The results of this SLR have important implications for theory. First, as there is a burgeoning number of studies on GPcI, particularly from within the last 5 years, the literature has become disjointed due to the different terms used for GPcI and the heterogeneity in the journals in which such studies have been published. Therefore, this study overcomes these issues and provides a holistic picture of the GPcI literature, which can prove helpful to researchers focusing on GPcI to widen the scope of their investigations.

Second, this SLR has segregated the GPcI literature into several themes, making it easier to visualise the various aspects of GPcI, which can further be used by scholars from different streams of management research to address the different challenges faced by firms, ranging from GPcI adoption to marketing and other related issues.

Third, this study unravels the various theme-based gaps in the GPcI literature and puts forth different RQs that can mitigate them. Furthermore, this study revealed that GPcI consists of clean technologies and end-of-pipe solutions; however, the broader literature has not discussed the two separately, which limits our understanding of the intricacies of GPcI. Future researchers should take note of this and make efforts to examine both technologies in detail.

Lastly, this study utilised the input–process–output model to present a systems view on GPcI. The model highlights the various input decisions required, the transformative processes involved and the resulting output in terms of the performance implications of GPcI. Researchers can use this model to empirically verify the impact of different antecedents and moderators in the GPcI process and the impact of such factors on the firm.

7.2 | Implications for business strategy and practice

The study has five key implications for managers and practitioners, which are summarised below.

First, the disentanglement of the GPcI literature into different themes provides a comprehensive overview of the topic, which is of

immense help to firms and practitioners. For instance, the review revealed that while firms are increasingly using Big Data to aid in their decision-making process, it requires making significant structural changes to amplify existing capabilities (Braganza et al., 2017). Accordingly, the management can reassess their strategies to adapt to such requirements.

Second, the management needs to respond to the changing demands of stakeholders and come up with a better strategic response, which includes changing their orientation from a business-centric approach to a more environmental-centric approach in addition to clean technological adoption. Likewise, management should focus on ingraining green ethics and ECSR into their organisational culture by explicitly setting policies and accepted behavioural norms at the workplace. Furthermore, the management should focus on developing political connections to lobby for stricter pollution regulations besides green taxes and subsidies. Doing so would further discourage the adoption and usage of non-green production technologies and thus grant the first-mover advantage to green firms.

Third, the managers must understand the value of organisational learning activities in their pursuit of GPcI. Furthermore, they must work on enhancing the external knowledge search and absorptive capacity of their firms, improving their Big Data exploitation techniques and entering into different strategic alliances and partnerships to learn new ways of doing things.

Fourth, although most of the studies included in this review were conducted in China, they still contribute to our understanding of the various dimensions involved in GPcI. However, managerial validation is still needed to unravel the limitations of these research efforts.

Lastly, the review revealed that regulatory, normative and imitative pressures significantly influence firms to adopt GPcI, thereby providing a basis for policymakers to introduce and strengthen such policies. Moreover, governments and other non-governmental agencies across the globe should unite to introduce national and cross-national environmental policies so that the existing loopholes in the system can be closed, and firms not adhering to these policies and adopting GPcI can be penalised through higher taxes, tariffs and sanctions.

7.3 | Limitations and future work

This SLR study has provided a comprehensive view of the state of the GPcI literature and identified key research gaps and future research directions. However, the contribution should be viewed in light of the following limitations. First, this SLR study has only included research papers published in the English language and that were available on the Scopus and WoS databases. As such, relevant studies published in other languages may have been omitted. In future systematic reviews, researchers can include conference proceedings and book chapters as well as studies published in other languages and that are available on other databases. The second limitation lies in the search and screening criteria and the complexities involved in the filtration of the relevant studies. As the literature on GPcI has been published in different journals with varying scope and focus, different terms have been used for GPcI. Although we used a robust set of keywords to maximise the chances of extracting relevant studies, some studies may still have been missed in this process. Likewise, the manual screening and filtering of studies may have been subject to human error. Although we did engage two researchers to do this part separately to minimise any errors and bias involved with such activity, future researchers should devise more robust techniques to tackle these issues.

CONFLICT OF INTEREST

The authors do not have any competing interests to declare.

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