Green business process management for business sustainability: A case study of manufacturing small and medium-sized enterprises (SMEs) from Germany

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ABSTRACT
Small and medium-sized enterprises (SMEs) have an important position in global sustainability since they are a prominent contributor to global pollution. It is challenging for SMEs to assess their level of business sustainability and identify actions to diminish environmental impact. Sustainability assessment models have been developed for this purpose, but a process focus is missing. Green business process management (Green BPM) aims at reducing the negative environmental impact of organizations through business processes rather than only considering final products and services. Combining literature from business sustainability and Green BPM, our study conceptualizes a Green BPM maturity model and, through multiple case study research, uses it to assess the Green BPM practices of ten manufacturing SMEs. The results reveal the level of business sustainability of SMEs based on six Green BPM factors: green attitude, strategy, governance, modeling, monitoring, and optimization. We further identify relevant benefits, pressures, and barriers that can drive or hinder Green BPM practices. Based on the findings, we make recommendations on how SMEs can accelerate their transition towards higher levels of business sustainability.

1. Introduction
Global warming has already reached a level of 1.2 °C, and given the current trajectory, recent predictions expect an increase of 2.7–3.2 °C by the end of this century (IPCC Working Group III, 2022; Stockwell et al., 2021). This increase is much higher than the 1.5 °C that the Paris Agreement aimed for, to keep humanity and the planet within a safe operating space. Research studies acknowledge the importance of business sustainability efforts for sustainable global development (e.g., Belas et al., 2021; Muff and Dyllick, 2014) and, particularly, green business process management (Green BPM) (Couckuyt and Van Looy, 2020; González et al., 2019; Hoesch-Klohe et al., 2010; Stolze et al., 2012). Companies have been increasingly engaging in sustainability programs; however, global sustainability indicators have not been improving (United Nations, 2022). There remains a “big disconnect” between micro-level action on the business level and macro-level environmental outcomes (Dyllick and Muff, 2016), which requires governments, businesses, and researchers to respond with extensive sustainability actions (Vásquez et al., 2021).

Much academic and public attention is given to sustainability initiatives for large corporations since those, individually, have much greater emissions and public exposure than small and medium-sized enterprises (SMEs) (Al-Hakimi et al., 2022; Cantele and Zardini, 2019). Collectively, however, SMEs are the most common form of business in Europe, accounting for 56.4% of value-added in the European Union (Caldera et al., 2018; European Commission, 2019), while contributing significantly to global pollution, for example, by generating more than half of the greenhouse gas emissions (Calogirou et al., 2010; Parker et al., 2009). SMEs have increasingly initiated sustainability activities, but it is not well understood how processes and sustainability outcomes are related in SMEs (Zhang et al., 2021). Therefore, more research is required on the sustainability of processes in SMEs.
Green business process management (Green BPM) is a new class of extended BPM practices for process design, execution, and monitoring, driven by the carbon footprint of business processes (Ghose et al., 2010). Green BPM is defined as “[…] the sum of all Information system-supported management activities that help monitor and reduce the environmental impact of business processes in their design, improvement, implementation or operation stages […]” (Opitz, Krüpp, and Kolbe, 2014a, 3812). The focus of Green BPM is on the optimization of business processes with respect to sustainability aspects. To achieve this, Green BPM recognizes the salience of processes in resource consumption and carbon footprint generation and provides a process lens to guide companies in their implementation of sustainability actions (Ghose et al., 2010). Opitz et al. (2014b) suggest a readiness model, which defines a set of factors that influence Green BPM initiatives in organizations. However, there has not been sufficient research to guide organizations in evaluating and improving the green maturity of their business processes (Gohar and Indulska, 2020).

It is challenging for SMEs to assess their sustainability efforts and identify directions to improve business sustainability (Mitchell, O’Dowd, and Dimache, 2020). Despite the established need for sustainability assessment tools, few researchers have developed frameworks to classify and manage business sustainability efforts (Bhatnagar et al., 2022; Vásquez et al., 2021). In particular, the Business Sustainability Typology (BST) by Dyllick and Muff (2016) has been used for classifying the concerns, the value created as well as the organizational perspective on sustainability on a spectrum of four business sustainability stages (Hermelingmeier and von Wirth, 2021). However, a major limitation of BST is that it does not provide an inclusive and clear process perspective. That is, it mainly refers to high-level ‘organizational perspectives’ about how a business handles sustainability facilitated through business processes. To address this shortcoming, we see an opportunity to integrate the BST with Green BPM.

The environmental cost of the manufacturing sector is particularly high since production processes are more resource intensive and have a greater carbon footprint than in other sectors (Boiral et al., 2014; Heimes et al., 2017; Moyeen and Courvisanos, 2012). In Germany and its 16 regions, SMEs are the backbone of the economy, which is depicted by the special name, ‘Mittelstand’, used for uniquely successful SMEs. Particularly in the rural Eifel-Mosel region of Rhineland-Palatine, SMEs constituted 99.5% of businesses and generated 42% of economic value added in 2017 (Böckmann et al., 2019; IHK Trier, 2020). In this region, the manufacturing sector is the second largest industry (IHK Trier, 2020). These reasons motivate our selection of manufacturing SMEs in the Eifel-Mosel region as the focus of analysis in this study.

To shed light on the process sustainability efforts in manufacturing SMEs and support them in their Green BPM initiatives, the key objective of this study is to assess the Green BPM practices in manufacturing SMEs. To address this objective, we first conceptualize a Green BPM maturity model by integrating the Green BPM readiness model with the four stages of the BST by Dyllick and Muff (2016). We use this model to assess the current maturity state of a set of ten manufacturing SMEs, identified with purposeful sampling, with respect to their Green BPM practices using multiple case study research. The case study approach for a specific geographic region is a prevalent research method to study SMEs (Helmdach and Röttgers, 2020; Moyeen and Courvisanos, 2012; Munoz-Torres et al., 2009; Quintás et al., 2018).

Our findings show a varying level of Green BPM maturity among the examined SMEs. Specifically, we find that all studied SMEs have a well-developed green attitude while most of them fail to develop and implement a fully-fledged green strategy and translate this into an effective governance structure, in alignment with the findings from large-scale business sustainability surveys for SMEs (e.g., Ipsos European Public Affairs, 2022; Shibamoto, 2022). Our study contributes to the literature in multiple ways. First, it combines the literature on Green BPM and business sustainability through developing a Green BPM maturity model for SMEs. The topic of business sustainability assessment has gained traction, and maturity models have been developed (e.g., Barletta et al., 2021; Shi et al., 2019; Vásquez et al., 2021); however, our model differs with its process focus for SMEs on sustainability maturity. Second, the case study results add to the literature by unveiling the status of business sustainability and exhibiting the operationalization of six Green BPM factors in manufacturing SMEs. Third, we identify dominant benefits, pressures, and barriers as factors that can drive or hinder Green BPM in SMEs with concrete examples of experiences and actions from the investigated SMEs. The model and the case study results can provide guidance, which is particularly required by SMEs (Mitchell, O’Dowd, and Dimache, 2020), for developing plans to improve process sustainability for various dimensions, such as green strategy, governance, or monitoring. We identify seven directions for SMEs that can guide them in their Green BPM practices, thus, improving business sustainability.

The reminder of the paper is structured as follows. Section 2 presents the related literature on Green BPM and the developed Green BPM maturity model. Section 3 explains the qualitative case study approach and motivates the choice of ten SMEs in the Eifel-Mosel region. Section 4 presents the research findings from the multiple case study including the results of the Green BPM maturity assessment and a structured analysis of the benefits, pressures, and barriers for the analyzed firms. Section 5 discusses the theoretical and practical implications, limitations, and avenues for future work. Lastly, we conclude the paper in Section 6.

2. Background and the green BPM maturity model

2.1. Green BPM

Virtually every organization, be it a multinational conglomerate or an SME, owns and manages several business processes for the efficient and timely delivery of services and products (Dumas et al., 2018). The discipline that is concerned with the management of business processes is business process management. In a typical BPM initiative, performance measures to monitor and assess business processes are time, quality, cost, and flexibility. Environmental impact is hardly considered a dimension to assess the performance of processes (vom Brocke, Seidel, and Recker 2012; van de Ven et al., 2022). Nonetheless, the extensive consumption of resources like energy, electricity, or water in the myriad activities of a business process has become an important target for business initiatives and scholarly writings on corporate sustainability (vom Brocke, Seidel, and Recker 2012; Couckuyt and Van Looy, 2020; Gohar and Indulska, 2015; González et al., 2019; Maciel, 2017; Stolze et al., 2012).

Ghose et al. (2010) put forward a new field called green business process management by integrating BPM and business sustainability, which has also been adopted and implemented in subsequent sustainability-focused studies (e.g., Ahmed and Sundaram, 2012; Couckuyt and Van Looy, 2020; González et al., 2019; Maciel, 2017; Opitz, Krüpp, and Kolbe, 2014b, 2014a). Green BPM is an approach to managing processes by adding sustainability to the traditional performance measures of time, cost, quality, and flexibility. The way business processes are executed to produce products and services directly affects business sustainability (van der Aalst et al., 2023). By implementing Green BPM practices, companies can take a process-oriented approach to corporate environmental sustainability rather than considering only the sustainability of their final products and services (Rozman et al., 2015). For example, consumable resources used in business processes would be tracked, and data on the use of a capital good in a manufacturing process would be collected to determine the end-of-life decisions for the capital good (Blengini et al., 2012).

Prior studies on Green BPM have suggested methods, techniques, models, and frameworks for managing business processes (González et al., 2019). Thus far, research in this field has mostly been qualitative and focused on the development of theoretical models (Houy et al., et al., 2021; Moyeen and Courvisanos, 2012; Munoz-Torres et al., 2009; Quintás et al., 2018; Testa et al., 2016; Thompson, 2014).
barriers constitute essential driving or hindering forces in Green BPM and, thus, are a crucial component to be added to a Green BPM model. (Brammer et al., 2012; Jansson et al., 2017; Seidel from large enterprises. However, little research has been performed on the empirical presence of sustainability practices (Cantele and Zardini, 2019).

While research on SMEs remains underdeveloped (Belas et al., 2021; Moyeen and Courvisanos, 2012; Munoz-Torres et al., 2009; Quintás et al., 2018; Testa et al., 2016), the insights from studies on the implementation of sustainability practices in all kinds of businesses are also applicable to SMEs. A recurring finding is that SMEs face certain barriers, pressures, and motivations in implementing sustainability activities (Brammer et al., 2012; Jansson et al., 2017; Meath et al., 2016; Seidel et al., 2010). One such barrier is the scarcity of their resources, such as factors of production, information, knowledge, support, time, and tools for approaching green practices (Kübler, 2020; Moyeen and Courvisanos, 2012; Quintás et al., 2018; Yacob et al., 2019). Testa et al. (2016) identified external pressures and the owners’/managers’ attitudes as the most important predictors of a firm’s sustainability efforts. In addition, the green attitude of the owners/managers has been confirmed as an important predictor of green practices (Boiral et al., 2014; González-Beníto and González-Beníto, 2006; Yacob et al., 2019). Similarly, Manninen & Huiskonen (2022) identified the sustainability orientation of top management to guide decisions. Additionally, resource availability and stakeholder pressure have been found to affect the environmental proactivity of firms (Boiral et al., 2014; González-Beníto and González-Beníto, 2006). The most central benefits identified in the literature are improvements of competitiveness, better public relations, a polished firm image, and long-term cost savings (Cantele and Zardini, 2019; Hrovatin et al., 2021; Salimzadeh and Courvisanos, 2015). Even though the authors did not specifically connect these forces to Green BPM initiatives, they nonetheless provide explanations of the various influences on sustainability activities in SMEs. Hence, existing research suggests that the benefits, pressures, and barriers constitute essential driving or hindering forces in Green BPM and, thus, are a crucial component to be added to a Green BPM model. However, the benefits, pressures, and barriers for manufacturing SMEs have been defined on a high-level by examining their relationship with the presence of sustainability practices (Cantele and Zardini, 2019).

Maturity models have found considerable use in guiding organizations to improve their business processes (Tarhan et al., 2016) and managing sustainability efforts (Vásquez et al., 2021). In this view, Bhatnagar et al. (2022) underscore the need for assessment tools of sustainability performance to understand sustainability issues and create improvement agendas. Barletta et al. (2021) developed a model to assess the sustainability readiness of manufacturing organizations. However, this study remains high-level and does not address business processes. Despite the indicated need to manage and improve the maturity of processes for sustainability, current BPM studies have not considered sustainability as the focus of process maturity (Cleven et al., 2012) or focused on a specific aspect of sustainability through processes (Couckuyt and Van Looy, 2021). Thus, Green BPM literature so far has not conceptualized sustainability stages or levels that would allow a mapping of firms along a sustainability spectrum. Dyllick and Muff (2016) suggest a typology for business sustainability, BST, which can be used to classify firms according to their sustainability efforts along four levels. This typology, however, relies on rather abstract constructs (such as strategy, leadership, and culture) and considered a process perspective only from a risk management and organizational embedding of sustainability (Dyllick and Muff, 2016).

To be able to assess the Green BPM maturity level of manufacturing SMEs, in this study, we propose the Green BPM maturity model depicted in Table 1. To develop this model, we have integrated the six factors of Green BPM defined in the Green BPM readiness model (Opitz, Krüp, and Kolbe, 2014b) with the four stages framework by Dyllick and Muff (2016). For this, the criteria identified for each stage are adapted and defined for every six factors of Green BPM initiatives in SMEs. The first column in Table 1 was taken from the BST framework and adapted to the case of Green BPM, creating four levels of Green BPM maturity. The second column, Green BPM Initiatives, was also defined based on how Dyllick and Muff (2016) described the distinct levels of business sustainability. The definition of the six core factors of the Green BPM readiness model (green attitude, green strategy, green governance, green modeling, green monitoring, green optimization) was used to develop and characterize the distinct Green BPM levels. The third column describes the necessary actions to transcend to a higher level, as adopted from the key shifts in the BST framework. We add the fourth column, the forces driving the shifts to a higher level of Green BPM, which explains the benefits, pressures, and barriers as the driving (or blocking) forces derived from Green BPM literature. This aspect allows us to analyze why and how companies are at a particular level or shift based on the identified decisive impact of benefits, pressures, and barriers to the implementation of sustainability measures in SMEs (Brammer et al., 2012; Jansson et al., 2017; Seidel et al., 2010) as discussed in Section 2.1.

In our Green BPM maturity model, Green BPM initiatives are allocated to four maturity levels of Green BPM in alignment with a typical maturity model structure (Vásquez et al., 2021). This allows SMEs to identify the necessary shift to get to the next stage. Each of the four levels of Green BPM refers to a distinct Green BPM maturity of a firm. Level 0 is tantamount to no Green BPM measures being implemented. Firms in levels 1, 2, and 3 have Green BPM initiatives implemented to varying degrees of detail and advancement. At level 1, the economic motivation to engage in environmental sustainability is still the prominent factor. Green BPM level 2 is characterized by a sound implementation of Green BPM and business processes creating value by fulfilling defined key environmental indicators (KEIs). Moreover, environmental objectives are realized as well as monitored and reported on, and business processes are continuously optimized to reduce emissions. In the highest level 3, a profound change in management takes place that puts true business sustainability at the core of the business model, and sustainability becomes the raison d’être. Important to mention is that, to transcend to the next highest level of Green BPM, a company needs to undergo three fundamental shifts. In the first shift from Green BPM Level 0 to Green BPM level 1, the importance of business sustainability is acknowledged, and a few first Green BPM initiatives are being implemented. In the second shift, the SMEs start pursuing value creation for their company by simultaneously reducing their environmental impact. Green BPM becomes a company competence just like conventional process management. The third shift is characterized by a change to an outside-in perspective that aims at doing business in line with environmental limitations compared to the predominant inside-out perspective. The SMEs employ Green BPM to facilitate the creation of a positive environmental impact through their business activities.

3. Research method

We used a case study approach to gain empirical insights into how Green BPM is implemented at different levels of maturity in manufacturing SMEs. Through the case study method, we aim to achieve the objective of this research by revealing the business sustainability practices of
SMEs in a certain region and identifying the benefits, pressures, and barriers they encounter. In our multiple case study research, we used semi-structured interviews to collect data on the Green BPM maturity level of the selected SMEs. We used a qualitative case study approach for several reasons. First, we assert that, to assess the maturity of Green BPM in SMEs, a qualitative case study is most suitable as this activity requires data on the subjective perceptions, experiences, and knowledge of stakeholders, environmental regulations

**Barriers:** lack of resources and knowledge, lack of tools and methods, high implementation costs, time

### Table 1: The Green BPM Maturity Model developed from the BST of Dyllick and Muff (2016) and the Green BPM readiness model of Opitz et al. (2014b).

<table>
<thead>
<tr>
<th>Levels of Green BPM (Dyllick and Muff, 2016)</th>
<th>Green BPM Indicators for Six Core Factors (Opitz, Krüp, and Kolbe, 2014b)</th>
<th>Necessary shift to the next level (Dyllick and Muff, 2016)</th>
<th>Forces driving the shift(s) (Literature in Section 2.1)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Green BPM Level 0</strong></td>
<td>No implementation of Green BPM</td>
<td>From Green BPM Level 0 to Level 1: broadening the BPM performance indicators and implementation of Green BPM initiatives</td>
<td>Benefits: improved competitiveness, public relations, firm image, and cost reduction</td>
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<tr>
<td></td>
<td><strong>Green attitude:</strong> not present</td>
<td></td>
<td>Pressures: external and internal stakeholders, environmental regulations</td>
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<td></td>
<td><strong>Green strategy:</strong> not implemented; profit maximization drives strategy, and it is the business imperative</td>
<td>From Level 1 to Level 2: value creation by reducing negative environmental impact; introduction of Green BPM practices</td>
<td>Barriers: lack of resources and knowledge, lack of tools and methods, high implementation costs, time</td>
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<tr>
<td></td>
<td><strong>Green governance:</strong> not pursued; the organizational structure not directed at Green BPM</td>
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<td></td>
<td><strong>Green modelling:</strong> not implemented</td>
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<td></td>
<td><strong>Green monitoring:</strong> not implemented</td>
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<tr>
<td></td>
<td><strong>Green optimization:</strong> not implemented; solely economic process performance dimensions/ traditional KPIs (time, cost, quality, flexibility) are pursued</td>
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<tr>
<td><strong>Green BPM Level 1</strong></td>
<td>Green BPM is a company goal; indications of Green BPM</td>
<td>From Level 1 to Level 2: value creation by reducing negative environmental impact; introduction of Green BPM practices</td>
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<td></td>
<td><strong>Green attitude:</strong> present; owners show sincere awareness for sustainability</td>
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<td></td>
<td><strong>Green strategy:</strong> partly implemented; sustainability goals are included in business strategy</td>
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<td></td>
<td><strong>Green governance:</strong> pursued tentatively; governance structure incorporates sustainable activeness</td>
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<tr>
<td></td>
<td><strong>Green modelling:</strong> partly implemented; some KEIs can be found in process definitions</td>
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<td></td>
<td><strong>Green monitoring:</strong> partly implemented; KEIs are monitored without dedication and continuity</td>
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<tr>
<td></td>
<td><strong>Green optimization:</strong> partly implemented; sustainability is somewhat considered in process improvements</td>
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<tr>
<td><strong>Green BPM Level 2</strong></td>
<td>Green BPM is a firm imperative</td>
<td>From Level 2 to Level 3: outside-in perspective on sustainability; fundamental philosophical change for SME; Green BPM used to create positive environmental impact</td>
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<td></td>
<td><strong>Green attitude:</strong> always present; owners realize and act on their environmental responsibility</td>
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<td></td>
<td><strong>Green strategy:</strong> fully implemented; separate sustainability strategy exists</td>
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<td></td>
<td><strong>Green governance:</strong> fully implemented; the SME is specifically organized to practice Green BPM</td>
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<td></td>
<td><strong>Green modelling:</strong> fully implemented; KEIs and environmental impact are included in process definitions</td>
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<td></td>
<td><strong>Green monitoring:</strong> fully implemented; processes are monitored for their environmental impact</td>
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<td></td>
<td><strong>Green optimization:</strong> fully implemented; all processes are optimized for better environmental performance</td>
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<td></td>
<td><strong>Green BPM facilitates the proactive creation of sustainability</strong></td>
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<tr>
<td><strong>Green BPM Level 3</strong></td>
<td>Green attitude: in addition to Level 2, owners/ managers are solely focused on business sustainability</td>
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<td></td>
<td><strong>Green strategy:</strong> in addition to Level 2, strategy guides to make a positive environmental impact as a business</td>
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<td></td>
<td><strong>Green governance:</strong> in addition to Level 2, management and employees are fully dedicated to their green strategy</td>
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<td></td>
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<tr>
<td></td>
<td><strong>Green modelling:</strong> in addition to Level 2, a significant focus is on the KEIs</td>
<td></td>
<td></td>
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<tr>
<td></td>
<td><strong>Green monitoring:</strong> in addition to Level 2, green process monitoring supports continuous business sustainability</td>
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<td></td>
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<tr>
<td></td>
<td><strong>Green optimization:</strong> in addition to Level 2, processes are optimized to operate sustainably</td>
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</tbody>
</table>

For SMEs, we acknowledge that semi-structured interviews are the appropriate source of observations to articulate the phenomenon deeply in practical settings.

#### 3.1. Description of the cases and case study approach

Purposeful sampling was used in selecting ten SMEs from the Eifel-Mosel region of Germany in this case study to reach a sample of...
interest for the study (Etikan et al., 2016). Particularly in the Eifel-Mosel region of Rhineland-Palatine, one of the 16 regions in Germany, the economy is dominated by private SMEs with a share of 99.5% and who collectively accounted for 42% of value-added in 2017 (Bockmann et al., 2019), and manufacturing sector is prominent. Hence, this region constitutes a good source of manufacturing SMEs that can be studied for their Green BPM practices (TrierHandelskammer, 2013). The selection criterion was for SMEs to pursue environmental actions. The SMEs were identified through the consultation of the German commercial register for the Eifel-Mosel region and a brochure of the Chamber of Industry and Commerce in Trier. Additionally, some SMEs were contacted upon referral by the interviewees. While some of the selected SMEs openly pursued environmental actions and won regional environmental contests, some did not explicitly communicate their sustainability activities. The study settled on ten SMEs as the themes, e.g., codes identified from the interviews, became saturated and to ensure that the amount of qualitative data was manageable (Shaw, 1999). Purposive sampling in this study for manufacturing SMEs in a certain area brings the benefit that all units of analysis share the same characteristics (Rai and Thapa, 2015), such as environmental conditions and regulatory requirements. The sampling, however, limits the representativeness of the findings to this specific region, which we acknowledge as a limitation.

Table 2 shows the characteristics of the SMEs as well as information on the interviewees and the conducted interviews. The SMEs one to six in Table 2 were observed to engage in environmental actions openly. The SMEs seven to ten did not communicate their environmental activities but still engaged in or had an awareness of business sustainability.

This research implements a multiple case study designed following the three components of the case study method described by Yin (2009). First, the research objectives were identified as presented in the Introduction. Second, the unit of analysis is specified as the micro-/firm level of SMEs. Third, the approach for analyzing the findings is explained below. As suggested by Yin (2009), semi-structured interviews were chosen as the mode of data collection. The ten semi-structured in-depth interviews with the owners/managers of the SMEs provided the primary data on the maturity of Green BPM and the perceived forces that may foster or prevent Green BPM initiatives. This primary information is essential in making a sound assessment of the SMEs Green BPM maturity level. The semi-structured design of the interviews allowed the interviewees to contribute information that may not have answered the questions directly but still proved to be valuable findings. Owners and managers of the SMEs were selected as interviewees to ensure that they have an overall knowledge of the processes in the company. The interviews were performed from 13 April to May 3, 2021. The interview process and the interview guide are explained in the next section. The interviewees’ responses and findings are analyzed through open coding (Elo and Kyngäs, 2008; Yin, 2009). Coding facilitates the pattern-matching technique, essentially grouping similar interview responses to discern dominant patterns in the findings (Elo and Kyngäs, 2008). The exact approach is explained in more detail in Section 3.3 below.

### 3.2. The interview process and the interview guide

We developed a semi-structured interview guide, as provided in Appendix 1, to assess the level of Green BPM maturity for the selected SMEs. We conducted interviews in German to ensure the owners/managers could express their perspectives naturally in their mother tongue. Subsequently, the responses were translated into English. The interview process is based on the guidelines for focus groups and in-depth interviews as set out in Ritchie et al. (2013). The interviews lasted between 35 and 60 min. They were conducted via phone or Zoom, and audio was recorded with the permission of the interviewees. The company and the owners/managers were kept anonymous to ensure the confidentiality of the responses. For the ordered conduct of the ten semi-structured interviews, the interview process proposed by Adams (2015) was employed. The interviews commenced with general questions to break the ice and establish a comfortable atmosphere. The core part of the interview covered questions about the development of the six elements of Green BPM in the SMEs and the benefits, pressures, and barriers faced by the SMEs. The second- and third-tier questions aimed to elaborate on the priority questions and were answered as time allowed.

#### 3.3. Data analysis and coding

We conducted data analysis using the approach suggested by Elo and Kyngäs (2008). The audio data gathered was transcribed and then imported into ATLAS.ti for open coding. An initial set of codes is identified based on the Green BPM maturity model and relevant literature on benefits, pressures, and barriers (identified in Table 1). They are extended with the new codes that emerged during interviews. The initial set of codes and sub-codes and the codes that emerged during interviews are reported in Table 3. The main codes were defined to assess the level of Green BPM and identify the benefits. The first main code, level of Green BPM, is assigned to responses that signal the maturity of the six factors of Green BPM in SMEs. The second code summarizes responses that could indicate a shift to a higher Green BPM level. The third, fourth, and fifth codes are matched with the respective benefits, pressures and barriers to Green BPM mentioned by the SMEs. The responses were matched to the codes. If new and relevant patterns surfaced in the data, they were added as new sub-codes.

### 4. Results

This section reports the results of our multiple case study research. We first describe the results of the Green BPM maturity level assessment of the examined SMEs. Then, the status of the six core factors; green attitude, green strategy, green governance, green modeling, green monitoring, and green optimization; is assessed for the SMEs. Next, we synthesize a list of the benefits, pressures, and barriers experienced by SMEs in the implementation of Green BPM.

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Table 2: Characteristics of the sampled SMEs.

<table>
<thead>
<tr>
<th>SME #</th>
<th>Industry Sector</th>
<th>Number of Employees</th>
<th>Years in Business</th>
<th>Interviewee Role</th>
<th>Length of Interview</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Sewage technology and biogas plants</td>
<td>125</td>
<td>63</td>
<td>Owner</td>
<td>51 min</td>
</tr>
<tr>
<td>2</td>
<td>Photovoltaic systems</td>
<td>5</td>
<td>11</td>
<td>Owner</td>
<td>37 min</td>
</tr>
<tr>
<td>3</td>
<td>Industrial pumps and machines</td>
<td>160</td>
<td>120</td>
<td>Manager</td>
<td>36 min</td>
</tr>
<tr>
<td>4</td>
<td>Thin sheet and plastics manufacturing</td>
<td>90</td>
<td>9</td>
<td>Manager</td>
<td>54 min</td>
</tr>
<tr>
<td>5</td>
<td>Wood processing and furniture</td>
<td>75</td>
<td>60</td>
<td>Owner</td>
<td>44 min</td>
</tr>
<tr>
<td>6</td>
<td>Primary plastics packaging</td>
<td>108</td>
<td>52</td>
<td>Manager</td>
<td>45 min</td>
</tr>
<tr>
<td>7</td>
<td>Switching devices</td>
<td>29</td>
<td>32</td>
<td>Owner</td>
<td>35 min</td>
</tr>
<tr>
<td>8</td>
<td>Mechanical engineering</td>
<td>50</td>
<td>32</td>
<td>Manager</td>
<td>53 min</td>
</tr>
<tr>
<td>9</td>
<td>Industrial process measuring and control</td>
<td>48</td>
<td>35</td>
<td>Owner</td>
<td>40 min</td>
</tr>
<tr>
<td>10</td>
<td>Industrial and personal elevators</td>
<td>59</td>
<td>69</td>
<td>Owner</td>
<td>48 min</td>
</tr>
</tbody>
</table>

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4.1. Assessment of the green BPM maturity and identification of indicators for green BPM factors

As a result of the Green BPM maturity assessment through interviews, the SMEs are grouped into diverse Green BPM maturity levels, as depicted in Fig. 1. On aggregate, the sampled SMEs were observed to exhibit characteristics of Green BPM Level 0 and level 1, while some were decided to not be on an exact level but on a shift between levels. The highest number of SMEs was positioned in Green BPM level 1. Below, we explain each group and report on the Green BPM practices they apply, which constitute the rationale for being placed in the respective maturity level. Table 4 summarizes the prevalent indicators of Green BPM maturity based on the six core factors of Green BPM in the ten SMEs.

As the only exemplar among the ten SMEs, SME 8 exhibits strong characteristics of Green BPM Level 0. The owner is clear in his green attitude and priorities for his company, “the focus is clearly not on sustainability” (Interviewee 8). Measures that reduce emissions are also primarily motivated by cost reduction and run under “[...] the disguise of energy efficiency and we can sell the machines to the customers for a higher price [...]” (Interviewee 8). The green strategy is such that electric and energy-efficient machines are purchased for mere compliance with international regulations, and environmental action is only taken if it makes economic sense for the business (Interviewee 8).

SMEs 9 and 10 were currently in a shift from Green BPM Level 0 to level 1. At the time of the interviews, the two owners/managers were in the process of preparing their company to implement the first Green BPM initiatives (Interviewees 9 & 10). However, their approach to implementing a green strategy and green governance were different. Whereas Interviewee 9 takes the leading role in creating a green strategy for his firm, Interviewee 10 relies on an external consultancy firm. Interviewee 9 is currently “[...] in the process of introducing an ERP system, and this causes us to revise and optimize our processes [...]”. For most of the questions, the owners responded, “our project will definitely result in a green strategy [...] currently we are still forming our green strategy” (Interviewee 10). Consequently, SME 9 and 10 are currently in the process of defining a green strategy and the approaches for green modeling, optimization, and monitoring to implement the first Green BPM measures.

The next group, SMEs that operate at Green BPM Level 1, include SME 3, 4, 5, 6, and 7. The practices they perform to reach level 1 are related to diverse Green BPM factors. For green attitude, the owners/managers realize their responsibility towards the environment and future generations and, thus, have decided to engage in Green BPM (SME 3, 4, 5, 6, and 7). SME 5 reports on its website that the environmental actions and motivation to produce with natural materials are clearly anchored in the company philosophy. SMEs 3 and 6 also clearly communicate on their website that the reduction of emissions is integral to their operations. Hence, SME 3 and SME 6 have a certified environmental management system and environmental reporting, which is indicative of business sustainability being anchored in the business strategy. Furthermore, related to green governance, the responsibilities for Green BPM are clearly defined, with the management being in charge but with varying involvement of the employees among the SMEs. Only SME 3 and SME 7 measure resource consumption in processes as an indication of green monitoring, but there is no established procedure to optimize the processes. Nonetheless, the traditional economic KPIs related to processes take precedence in the green optimization and green modelling. Thus, green modeling, green optimization, and green monitoring are only weakly developed in the five SMEs. Consequently, specific KEIs are not formulated or added as indicators in the process definitions. Rather than being constantly monitored, the management merely keeps an eye on the water, energy, and electricity usage. Moreover, none of the SMEs employ information systems to support green modelling and green monitoring. All interviewees stated that they are continuously looking for new opportunities to make their business processes greener, but they face certain limitations. For example, Interviewee 4 states, “[...] what we can do, we are already doing”. Moreover, Interviewee 6 rather sees physical limitations to making their business processes greener as they are processing plastics. In summary, at this level, the firm’s economic performance still took precedence and Green BPM is performed when it makes economic sense to do so.

SME 1 and SME 2 are in the shift from Green BPM level 1 to 2. They have sustainable business models that create economic value with solutions that foster sustainable development. The first SME develops and produces sewage technology and biogas plants, and the second SME plans, produces, and installs solar plants. These products generate green energy, and the wastewater system provides pure drinking water. Hence, the green attitude and the green strategy are clearly on making a positive impact, which is a characteristic of Green BPM level 3. For example, Interviewee 1 defines that “we have our own patents on our procedures [...] like the removal of microplastics and micropollutants”. Nonetheless, pursuing an inherently sustainable business model does not necessarily mean that the business processes are carbon neutral. Even though business processes facilitate the production of biogas and solar plants, they are currently not carbon neutral (Interviewees 1 & 2). Although their green attitude and green strategy are in level 3 due to the nature of the products they manufacture, SME 1 and SME 2 are overall positioned at the shift from level 1 to 2 since their green modelling, green optimization, and green monitoring to support the business model are implemented but not fully developed. The reason for this positioning is that, from a managerial perspective, SME 1 and SME 2 treat a green attitude and green strategy as the business imperative, but the Green BPM practices are not fully implemented.

In conclusion, four distinct groups of SMEs could be identified at diverse Green BPM maturity levels. The group comprising most SMEs is Green BPM level 1. In this group, two SMEs produce sustainable products, but their business processes still have a negative environmental
Summary of interview findings on the indicators related to the six core factors of Table 4

1. Green Attitude
- The sense of responsibility towards SME 1, 2, 3, 4, 5, 7 & 9
- External and internal stakeholders SME 4, 5 & 7
- Having personal conviction and perceiving role model function in sustainability SME 1, 3, 4, 5 & 6
- Green attitude manifested in the firm philosophy SME 1 & 2
- The SME finds meaning in the reduction of negative environmental impact SME 3, 4, 6, 8 & 10
- Business opportunities in Green BPM measures SME 1, 4, 8, & 9
- Economic viability is a priority SME 3, 4, 6, 8 & 10

2. Green Strategy
- Business sustainability embedded as part of the business strategy SME 1, 3, 4, 5 & 6
- The green strategy is part of the overall business strategy SME 3, 4, 5, 6, 7 & 9
- Promoting sustainability is the foundation of the business model SME 1 & 2
- Small-scale measures without a specific green strategy SME 4, 5, 8, 9, & 10

3. Green Governance
- Senior management gives general/unspecified instructions to employees to avoid resource waste SME 2, 4, 5, 6, 8 & 9
- Delegation of sustainability measures to every employee SME 2, 4, 5, 6, 8, & 9
- Collective definition of strategic goals SME 1, 2, 4 & 5
- Senior management responsible for Green BPM SME 4, 6, 8 & 9
- The SME does have a position directed at promoting sustainability SME 3

4. Green Modelling
- Processes are defined in the form of texts and/or models, but no inclusion of KEIs SME 1, 4, 5, 6, 7, 8 & 10
- Business processes are not defined; they are merely in the memory of employees SME 2 & 9
- There exists documentation for quality management systems and modeling tools (e.g., Microsoft Visio), but KEIs are not documented SME 1, 4, 5, 6 & 10

5. Green Optimization
- Continuous process optimization but not always to reduce process emissions SME 1, 4, 5, 6, 8, 9 & 10
- Green optimization is a consideration in process optimization; limited optimization along KEIs SME 4, 6, 8, 9 & 10
- Environmental performance of processes often neglected SME 2, 4, 6, 8, 9 & 10
- Consultation of external advice SME 2, 4, 6, 8, 9 & 10
- Employee suggestions for greater sustainability are considered SME 1 & 10

6. Green Monitoring
- The SME has access to and analyses data on process execution and KPIs, but no KEIs are monitored SME 1, 4, 5, 7, 8, 9 & 10
- Resource use is checked only on demand and irregularly SME 2, 5 & 6
- Process emissions are not monitored SME 1, 3, 4, 5 & 6
- No specific information system is used to assist or automate green monitoring, merely generic ERP systems SME 1, 2, 3, 4, 5, 6, 9 & 10

Fig. 1. Categorization of the SMEs along the levels of Green BPM

4.2. Benefits, pressures, and barriers of green BPM initiatives

In this section, we report on the perceived benefits, pressures, and barriers in developing Green BPM practices for manufacturing SMEs identified from interviews. A summary of the dominant benefits, pressures, and barriers and SMEs experiencing those are presented in Table 5.

4.2.1. Benefits of the green BPM initiatives

Cost reduction due to the optimization of the resource consumption in the execution of the business processes is a benefit that all interviewees mentioned. There are two sources of cost reduction: own generation of energy and electricity through, e.g., solar plants, and the savings in process inputs through more efficient activities (Interviewees 1, 2, 5, 6, 7, 8, and 9). Interviewee 1 notes a number of “little effects like water and energy savings”. Also, Interviewee 5 “[…] saves in the long run the course also money.” For Interviewee 2, “[…] the CO2 savings through the solar plant on our premises […]” is at the same time the greatest source of cost reductions. Another form of cost reduction is achieved through the generation of less waste and the subsequent reductions in waste disposal costs (Interviewees 2, 4, 6, and 9). “The amount of waste continuously increases, and the waste disposal costs are high, and through waste reduction, money can again be saved” (Interviewee 2).

An important benefit that leads to cost reduction is increased process efficiency. This benefit emerges due to the removal of rework activities in processes (Interviewee 2). Interviewee 4 has invested a lot of time and effort to reduce rework and minimize the excess production, which ultimately results in more efficient processes with resource saving, thus, bringing the benefit of reduced costs. Process efficiency also entails using less materials in the production processes, e.g., replacing paper through digitalization (Interviewee 9).

Aside from the number of SMEs who state they experience considerable cost savings, Interviewee 3 specifies that “To be honest and from an economic perspective, the cost reduction is close to 0 […]”. Interviewee 7 is also more pessimistic about cost reductions, “otherwise we do not experience any positive effects, aside from a reassurance of the conscious”. Interviewee 4 is also straightforward, “cost reductions will not motivate me much because I do not think that there will be large cost reductions from sustainable process optimization […].” Hence, the owners/managers decide on new measures based on the resources they have available and not for the benefits they perceive (Interviewees 4 & 6). Consequently, the benefits of Green BPM are still being subordinated to the SME’s economic performance.

Another common benefit noted by the SMEs is the maintenance of good customer relationships (Interviewees 1, 2, 3, 4, 5, 6, and 10). The SMEs see sustainability as a force that attracts customers with a sustainability awareness, and “the sustainability of our customers is, of course leading” (Interviewee 1). The customers themselves investigate how resource conserving the production is, and, thus, they positively note the Green BPM initiatives by the SMEs (Interviewees 3, 5, and 6). One owner observes that “[…] we have a lot of customers who enquire on how and
Table 5

<table>
<thead>
<tr>
<th>Forces driving/hindering Green BPM</th>
<th>Dominant Findings</th>
<th>SMEs</th>
</tr>
</thead>
<tbody>
<tr>
<td>Benefits</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cost reduction</td>
<td>SME 1, 2, 5, 6, 7, 8, 9</td>
<td></td>
</tr>
<tr>
<td>Increased process efficiency</td>
<td>SME 2, 4, 9</td>
<td></td>
</tr>
<tr>
<td>Good customer relations</td>
<td>SME 1, 2, 3, 4, 5, 6, 10</td>
<td></td>
</tr>
<tr>
<td>Positive firm image</td>
<td>SME 1, 3, 4, 5, 10</td>
<td></td>
</tr>
<tr>
<td>Improved profitability</td>
<td>SME 1, 4, 6</td>
<td></td>
</tr>
<tr>
<td>Improved competitiveness</td>
<td>SME 1, 4, 6</td>
<td></td>
</tr>
<tr>
<td>Pressures</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Internal stakeholder pressure</td>
<td>SME 2, 6, 8, 10</td>
<td></td>
</tr>
<tr>
<td>Retention of customers</td>
<td>SME 2, 6, 8, 10</td>
<td></td>
</tr>
<tr>
<td>Pressure from financial institutions</td>
<td>SME 8</td>
<td></td>
</tr>
<tr>
<td>Barriers</td>
<td></td>
<td></td>
</tr>
<tr>
<td>High implementation costs</td>
<td>SME 2, 3, 5, 7</td>
<td></td>
</tr>
<tr>
<td>Lack of time</td>
<td>SME 2, 4, 7, 9, 10</td>
<td></td>
</tr>
<tr>
<td>Lack of resources and knowledge</td>
<td>SME 2, 3, 4, 5, 7, 8</td>
<td></td>
</tr>
<tr>
<td>Lack of sustainable products</td>
<td>SME 4, 5, 6</td>
<td></td>
</tr>
<tr>
<td>Bureaucracy</td>
<td>SME 1, 2, 3, 5, 9, 10</td>
<td></td>
</tr>
</tbody>
</table>

where the products are produced.” (Interviewee 5). Especially the largest customers have the most impact on motivation, “[…] a big customer of ours grants points […] and even awards that we have put up in the hallway” (Interviewee 6). This shows the importance of being situated in a value chain where an SME supplies products to large enterprises interested in increased sustainability. The owners/managers consider better customer relations as a benefit as it ultimately means higher revenue. This supports the notion that economic interests prevail over environmental concerns.

Connected to better customer relations is the positive firm image that not only addresses and attracts new customers but also new personnel and talent that have environmental awareness (Interviewee 1, 3, 4, 5, and 10). The effect is described by Interviewee 1 as “we definitely profit from that […] also in the firm image for customer and skilled personnel acquisition […]”, which relates to higher employee satisfaction. However, Interviewee 1 clarifies that the enhanced firm image cannot be recognized immediately, “[…] this is a long way” (Interviewee 1). Most interviewees indicated that they experienced some improvements but not by much (Interviewees 2, 3, 6, and 10). Again, other SMEs specifically state that they do not experience a polished firm image (Interviewees 4 & 8). Interviewee 7 receives its orders because of the firm’s quality and competence and not for the environmental measures it adopts.

Other notable positive effects are improved profitability and improved competitiveness (Interviewee 1, 4, 6). Interviewee 1 puts it directly as “[…] we do economic and ecological sustainability with increasing profitability.” (Interviewee 1). Also, Interviewee 6 notes increased profitability while saving energy and electricity, and Interviewee 4 sees an improved position vis-à-vis large competitors. Nonetheless, there are SMEs who cannot record increases in profitability but who initially only feel the weight of the investments in Green BPM (Interviewee 3). Moreover, Interviewee 3 has a distinct experience and does not “sell more pumps just because we are trying to preserve the environment” and “no employee comes here because we are taking environmental measures” (Interviewee 3). One benefit identified from the literature, public relations, was not explicitly mentioned during interviews.

To summarize, the major benefits of Green BPM initiatives perceived by the sampled SMEs are cost reduction, good customer relations, positive firm image, and profitability. These benefits are of an economic nature and again underline the commercial interest in Green BPM compared to making a positive environmental impact. However, the degree to which the owners/managers experience these positive effects varies among the SMEs. The greatest variation is in the noted cost reductions. A dominant theme is that the benefits like cost reductions or better customer relations motivate the owners/managers to adopt additional Green BPM measures (Interviewees 2, 5, 6, and 9). Interviewee 5 answers, “the subsequent investments become easier because we made good experiences […] for example, we started with one solar plant, and then we bought the second, and now we have a third […]”. Additionally, the SMEs note the benefits of new measures much quicker and more intense (Interviewees 5 and 9).

4.2.2. Pressures for the green BPM initiatives

Overall, the sampled SMEs reported experiencing few pressures from internal stakeholders like employees and external stakeholders like customers, regulators, and society in general. Improved customer relations were before mentioned as a benefit of making processes greener, but for Interviewees 2, 6, 8, and 10, customers also exert pressure for the firms to become more environmentally sustainable. According to Interviewee 10, the most pressing force to establish a green strategy is the retention of customers, emphasized as “[…] mainly we hope to retain our customers through sustainable measures, that was clearly communicated to us […]” (Interviewee 10). This interviewee indicates that the customers would remove the firm from the supplier list if they would not engage in environmental activities. Consequently, these SMEs take Green BPM measures “[…] to meet the expectations of our customers” (Interviewee 10). Interviewee 6 was directly approached by one of its biggest customers, who enquired about the carbon footprint of their production processes as a major indication of this pressure.

Interviewee 6 experienced pressure from financial institutions for the conditional granting of loans: “[…] I had a bank coming in the other day, and they said that sustainability is a factor in the bank’s rating […], and they said that by 2040, they would solely be cooperating with sustainable businesses […].” Thus, four SMEs are predominantly driven by external stakeholders to engage in Green BPM and not from intrinsic motivation or a green attitude.

Aside from these four SMEs, none of the other SMEs indicated that they feel any pressure from third parties to become more active in Green BPM (Interviewees 1, 3, 4, 5, 7, and 9). The owners/managers almost unanimously declared that the Green BPM measures only originate from intrinsic motivation (Interviewees 3, 4, 5, 7, and 9). “I would have to think, but I do not believe that we are taking any measures out of pressure.” (Interviewee 1). Interviewee 2 agrees, and they currently have “[…] no restrictions and experience no pressure from outside”. Interviewee 4 similarly states, “well, pressure, I have never heard that; it all comes from within […] we want to become active”. Interviewee 5 is also very concise in stating, “we have no pressure, and we also have no regulations that create pressure […].” Also, Interviewee 3 comments, “we do not feel pressure at this point, well it is all mere inquiries on how we are operating […].” Interviewee 3 concludes, “no company is much interested if we are investing in sustainability or not […].”

A pressure found in literature, environmental regulations, was observed as an incentive rather than pressure by two SMEs. Interviewees 1 and 7 advocated the creation of positive incentives by the regulators and politics at large instead of exerting pressure on SMEs to reduce their carbon footprint. Politics “should create incentives and not exert pressure; that is a strategy we are also pursuing internally […]” (Interviewee 1).

In sum, there is almost an even divide between SMEs who do experience pull from internal or external stakeholders and those who are unaffected by any pressure and engage in Green BPM for their own conviction and a green attitude. The customers are the main drivers and either directly or indirectly impact the green business strategy. However, even those SMEs who perceive pull from external stakeholders are not ultimately driven by such pressure. With regards to the key shifts, the pressures are not decisive in the decision on new and higher-level Green BPM measures (Interviewee 2, 4, 5, and 9). Hence, the shifts are not driven by pressure but rather by internal motivation.
4.2.3. Barriers to the green BPM initiatives

The previous two forces, benefits and pressures, result in the definition and implementation of Green BPM measures. This section reports the barriers to the adoption of Green BPM measures perceived by the interviewees. High implementation costs of the large investments needed for process optimization are the most prominent deterring factor mentioned by the interviewees. For Interviewee 3, the initial barrier was “[…] financial obstacles; we were close to insolvency and also had to bear this huge renovation damage”. Similarly, Interviewees 5 and 7 were constrained by the financial means available to them and the share they are willing to invest in Green BPM measures. An important observation is that most SMEs do not perceive barriers but rather hurdles to taking Green BPM measures that the firms can actually overcome (Interviewees 5, 6, and 7). “Costs are a hurdle, but nothing that keeps us from making these investments […] we have hurdles, yes, but they are not insuperable” (Interviewee 5). Additionally, Interviewee 2 mentions, ‘financial means and time and manpower, that is the biggest problem, we cannot even manage our workload as it is […]’ (Interviewee 2). In sum, the interview responses indicate that financial means are missing and not merely the willingness to invest available money.

With this, Interviewee 2 already points to the second most mentioned hurdle to taking environmental action, lack of time. For these SMEs, the implementation of Green BPM measures requires a lot of time investment that would risk daily business activities (Interviewees 2, 4, 7, 9, and 10). “Especially the owners of SMEs are much involved in the daily business […] and although they are willing to, we simply lack the time and a little incentive” (Interviewee 7). The lack of prioritization also swins with some interviewees’ responses. The owners of SME 2, 7, and 9 see little opportunity for themselves to manage the time constraint. Interviewee 9 asserts that the owners “cannot deal with the topic because they are too involved in the daily business, which is, however, self-inflicted […]”.

Closely connected to time is also a lack of resources and knowledge of what Green BPM measures to take and how (Interviewees 2, 3, and 7). The firm size is again a much-referenced example of resource limitation (Interviewees 2, 3, 4, 5, 7, and 8). The SMEs are “certainly willing to take measures, but we have to stay profitable […]” (Interviewee 3). Interviewee 7 needs “[…] a leading actor like a commercial or handicrafts chamber that guides the SMEs through instructions […]”. Several SMEs also cite bureaucracy as a burden to applying for subsidies for investments in the sustainability of BPs (Interviewee 1, 2, 3, 5, 9, and 10). “[…] the bureaucracy for grant applications keeps many SMEs from implementing measures; this constitutes an obstacle […]” (Interviewee 2).

A further hurdle is the lack of sustainable products available as input for the business processes (Interviewees 4 & 5). The SMEs are still searching for appropriate alternatives to aluminum or plastics with similar durability and quality. Interviewee 5 stated, “as soon as there is something available that meets the standards, we can talk about employing it in our production”. The introduction of products with novel components that would risk daily business activities (Interviewees 2, 4, 7, 9, and 10). “Especially the owners of SMEs are much involved in the daily business […] and although they are willing to, we simply lack the time and a little incentive” (Interviewee 7). The lack of prioritization also swins with some interviewees’ responses. The owners of SME 2, 7, and 9 see little opportunity for themselves to manage the time constraint. Interviewee 9 asserts that the owners “cannot deal with the topic because they are too involved in the daily business, which is, however, self-inflicted […]”.

4.2.4. Overall results for benefits, pressures, and barriers of the green BPM initiatives

SMEs in the analyzed sample indicated three of the four benefits identified from the literature: improved competitiveness, positive firm image, and cost reduction. They only did not indicate public relations found in the literature. Additional benefits of Green BPM were identified as good customer relations, improved profitability, higher employee satisfaction, and increased process efficiency. Cost reduction is a benefit indicated by most SMEs, while some SMEs indicate no cost reduction. SMEs that indicate this benefit are positioned in diverse maturity levels. Thus, the experience of this benefit is not related to maturity. Firm image is revealed as a major benefit too, but it also includes controversies. Some SMEs do not find it a recognizable benefit, even from firms with a high Green BPM maturity level.

The pressures indicated by SMEs mostly match the pressures found in the literature. However, diverse experiences exist among SMEs. Some explicitly refer to pressure from internal and external stakeholders. Others explicitly mention they do not feel any external stakeholder pressure. A common pressure indicated in the literature, environmental regulations, was not indicated by these SMEs. This can be related to the country and the domain of the sample. Additionally, SMEs may be subject to a different set of regulations than large enterprises. Those SMEs that indicates no pressure are also in diverse levels of maturity.

Several barriers are especially found to be prominent for SMEs. The time and resources that SMEs need to allocate to Green BPM incentives particularly impact their daily business activities to a large extent. That is why they have difficulty in undertaking these incentives, although they are observed to have sufficient internal motivation. The lack of sustainable products is a barrier that was not identified in the literature. This may also be specific to SMEs since they may have less power to reach different markets and impact their customers in the supply chain to change their preferences on the end product. The lack of tools and methods, a barrier identified from the literature, was not expressed by the sampled SMEs.

5. Discussion

In this study, we developed a Green BPM maturity model to help SMEs assess their Green BPM maturity levels and to guide them in improving their maturity. Next, we established an in-depth understanding of the Green BPM maturity state of ten manufacturing SMEs in Germany. We gained insights into their Green BPM practices through six core factors of Green BPM and revealed the benefits, pressures, and barriers they experience to Green BPM.

5.1. Theoretical contributions

Our study provides several theoretical contributions to the field of business sustainability in SMEs and the emerging discipline of Green BPM. First, the study combines the literature on business sustainability and Green BPM through multiple case study research. Assessment of the maturity of sustainability efforts in organizations has attracted major research interest. Many scholars developed models for maturity assessment of sustainability for a particular production type or technical aspects rather than business sustainability, such as smart manufacturing systems development (Shi et al., 2019), sustainable product design (Watz and Hallstedt, 2020), and remanufacturing operations (Golinska and Kuebler, 2014). Barletta et al. (2021) developed a model for assessing organizational capabilities specifically for manufacturing practices, such as materials and assets used for manufacturing, without a focus on the size of the company. Research asserts that SMEs need specialized support to improve their sustainability practices (Mitchell, O’Dowd, and Dimache, 2020). Accordingly, Vásquez et al. (2021) developed a sustainability maturity model for SMEs on the factors of environmental knowledge of the employees and implementation of environmental strategies, practices, and related information systems.
This model considers the existence of processes for improving environmental performance but not the management of business processes with a sustainability perspective. To our knowledge, the current study is the first on sustainability maturity with a process focus for SMEs.

Second, we argue that our Green BPM maturity model provides a sound theoretical lens to assess Green BPM practices in organizations. This model was created by unifying the BST framework by Dyllick and Muff (2016) and the readiness model by Opitz et al. (2014b). The model facilitates the categorization of companies along different maturity stages of Green BPM. The model’s strength is the assessment of the level of Green BPM maturity based on the core organizational factors (green attitude, strategy, and governance) and the operational factors (green modeling, optimization, and monitoring) of Green BPM. Additionally, the model accounts for the shifts from one level of Green BPM to the next, during which firms undergo a fundamental change in the organizational and operational factors. Hence, this model extends the BST framework and can be used to first assess the current level of Green BPM in the SMEs, and then to identify the changes needed to transition to the next higher Green BPM level. Thereby we enhance the comprehensiveness of the theoretical frameworks. Practically, such guidance is particularly important for SMEs, which need more support in implementing green practices than large enterprises (Mitchell, O’Dowd, and Dimanche, 2020).

Third, we exhibit the Green BPM maturity of ten manufacturing SMEs in Germany through the application of the proposed maturity model. Through in-depth interview analysis, our study extends the literature by demonstrating concretely how the six core factors of Green BPM are operationalized in manufacturing SMEs. The findings on the Green BPM maturity levels of the SMEs are generally in line with the previous findings on business sustainability maturity. In our sample, most SMEs are placed in Green BPM maturity level 1 and none in levels 2 or 3. In the manufacturing sector, it is typical that most SMEs lie in a mid-level maturity in terms of being aware of sustainability practices and putting in place strategies, and the number of manufacturing SMEs on top sustainability levels is limited (Vásquez et al., 2021). The results of large surveys from Europe (Ipsos European Public Affairs, 2022) and Japan (Shibamoto, 2022) suggest that SMEs are weak at practicing green business, while their environmental awareness is relatively high. Similarly, in our sample, for the SMEs that are in the maturity level of a shift from 1 to 2, green attitude, which is the factor about Green BPM awareness, was assessed to be in a higher maturity, level 3. To be expected due to the most common barrier for SMEs, financial constraints (Meath et al., 2016), we did not observe the use of environmental information systems other than the use of ERP systems to apply certain sustainability practices. SMEs would increase business sustainability through improved green modeling and green monitoring by enhancing their maturity of implementing information systems, particularly data analytics (Korsten et al., 2022).

Fourth, we identify dominant benefits, pressures, and barriers, which are the forces that promote or hamper Green BPM in SMEs. This addition also makes the theoretical framework more comprehensive by introducing critical factors that illustrate how transitions to higher levels of business sustainability are being shaped. Our findings confirm and extend the benefits, pressures, and barriers identified in the SME case studies (e.g., Boiral et al., 2014; Quintas et al., 2018; Testa et al., 2016; Yacob et al., 2019). Through the in-depth data collected through interviews, our study brings a deeper understanding of the forces identified in the literature for sustainability in SMEs in which we are studying on archival data (e.g., Meath et al., 2016; Mitchell, O’Dowd, and Dimanche, 2020) and provide concrete examples of experiences and actions of manufacturing SMEs. For example, our findings set an example that a major barrier for SMEs, the high implementation costs of large environmental investments, can be overcome through gradual investments. Likewise, although we confirm the pressure from internal stakeholders as a common motivator for Green BPM, our findings depict that many SMEs are just highly driven by an internal motivation to improve the level of business sustainability. Additionally, we observe good customer relationships as an additional benefit to the literature when the ecosystem of the SME is already focused on improved sustainability. Thus, the ecosystem in which the SME is situated seems to be a determining factor for the forces that the SME experiences.

5.2. Practical implications

Our study findings suggest several managerial implications for developing Green BPM practices in SMEs. First, the green attitude among SMEs provides fruitful ground for the definition of a concrete green strategy in line with the business strategy. However, it is observed that it is challenging for SMEs to implement green strategies in their processes since the owners are mainly occupied with daily business. In sum, the managers are motivated to engage in the implementation and subsequent execution of Green BPM measures, but the extent of their current implementation is rather limited. Second, our study warrants that managers need a holistic and strategic approach to Green BPM that also realizes green modeling, green optimization, and green monitoring. Before adopting Green BPM measures, a rigorous analysis of the existing business processes is required. To do so, managers need to overcome perceptions and the status of KEIs. Therefore, managers should focus on defining processes and identifying KEIs related to processes to establish a continuous green monitoring system.

Third, to create a positive impact, those SMEs who produce unsustainable products should investigate the use of more sustainable materials. Some SMEs we interviewed have already investigated this possibility, but no suitable alternatives were found that could satisfy suppliers’ quality requirements. Hence, an important strategy would be to converse with the suppliers to first discover or develop alternative and sustainable materials as process inputs. Lastly, clear communication with the customers would help SMEs elicit their quality requirements also regarding sustainable products, which may result in innovative ideas for sustainable product design (Bhatnagar et al., 2022). Since SMEs do not typically have sufficient power to guide sustainability goals in their ecosystem (Heikkurinen et al., 2019), they should interact with large players in the value chain to impact sustainability requirements. The interviews have shown that managers cannot expect to shift their business to the next higher level of Green BPM without incentives, ideas, expertise, and knowledge from outside. According to the findings of this study, the managers/owners of SMEs are advised to.

1. Consult external advice to gain expertise, knowledge, and ideas on potential Green BPM measures and to advance the level of Green BPM. Only two SMEs in our sample were observed to consult external advice.
2. Form a trade association solely targeted at exchanging experience on environmental management, Green BPM measures, and pooling of resources and knowledge, as suggested by an interviewee. The aim of such an association or convention is the provision of mutual support among business people.
3. Search the dialogue and cooperation with customers and suppliers to develop and produce alternative, sustainable materials themselves. Three SMEs in our sample have use for sustainable inputs but thus far have not found suitable alternatives.
4. Impact your ecosystem by engaging in efforts to influence the big partners in the supply chain on implementing sustainability practices. This would allow green SMEs to take an advantageous position as a supplier and open up new Green BPM opportunities, such as implementing green logistics processes and access to sustainable inputs and information systems.
5. Define and constantly monitor KEIs. To first get a thorough understanding of the firm’s carbon footprint and then, rather than just measuring, use the KEIs as the basis of decision-making for green optimization. Two SMEs in our sample measured KEIs without using them for optimization, hindering the benefit of having KEIs.
6. Consider using information systems to reduce the effort required for green modeling, optimization, and monitoring practices. Use the knowledge and potential to access information system resources from the value chain (e.g., access to individual licenses rather than purchasing a product).

7. Apply the Green BPM maturity model to establish strategic goals to reach the next higher level. The model enables the owners/managers to assess their current level and then identify measures to advance to the next level.

5.3. Limitations and future research

As with any research account, the present study also exhibits limitations that need to be acknowledged. An inherent limitation of case studies is the lack of generalizability of the findings to other settings. However, the overall aim of this study is not the generalizability of findings, but the creation of first impressions of the level of Green BPM in ten manufacturing SMEs as no previous account has yet combined the research on sustainability in SMEs and Green BPM. Another limitation is that the selection of SMEs for interviews did not follow random sampling. Instead, the SMEs were selected based on their environmental activities. The authors nonetheless took the necessary measures and observed that the sampled SMEs reasonably represent the landscape of manufacturing SMEs in the Eifel-Mosel region.

Several avenues for further research could be identified. First, quantitative follow-up studies can be conducted to investigate the importance of the identified benefits, pressures, and barriers for achieving Green BPM. Moreover, a quantitative investigation of the possible relationship between the perceived benefits, pressures, and barriers and the shifts from one level of Green BPM to the next would allow the extension of the study to SMEs in other resource intensive industries as well as service sectors in varying industries. Service providers may process fewer physical resources for the provision of the final service, but they account for an ever-increasing share of economic activity in developed and developing countries (Vásquez et al., 2021). Consequently, analyzing BST efforts in the service sector is a valid avenue for further research. Third, using the Green BPM assessment results of this study, SMEs can be supported further by developing tools and action plans for their sustainability actions (Mitchell, O’Dowd, and Dimache, 2020). To achieve this, the maturity model can be extended to achieve a prescriptive purpose (Poppelbühl and Roglinger, 2011), for example, by deriving best practices for certain domains such as smart manufacturing (Barletta et al., 2021) and identifying capabilities and factors needed specifically for process automation and data analytics (Aysolmaz et al., 2023). Fourth, the consideration of different domains and contexts can also be valuable for distinguishing how forces apply differently and guiding SMEs better. For example, the cost reduction benefit may depend on the domain and the type of products and services provided by an SME, while the pressure of stakeholders perhaps mostly depends on the ecosystem the SME is situated in. Fifth, for green monitoring of processes, SMEs can be supported by providing example KEIs to evaluate the sustainability of various aspects of their processes and using information systems to measure those KEIs using process execution data (van der Aalst et al., 2023; van de Ven et al., 2022). Sixth, large firms and SMEs are different in the most elementary aspects of a business, and thus, it would be of added value to conduct a comparative case study between Green BPM measures in SMEs and large firms. For example, the benefit of improved public relations and the barrier of lack of tools and methods were not observed in our sampled SMEs. Revealing the reasons behind such differences can help SMEs to better guide their Green BPM efforts.

6. Conclusion

While many organizations have been putting considerable effort into reducing the environmental impact of their business processes, there is a gap in research on developing Green BPM initiatives. This issue is a major challenge, specifically at the SME level. This study addresses this challenge by conceptualizing a Green BPM maturity model and applying it in the manufacturing SME context. Following multiple case study research, we find that most of the investigated SMEs have a moderate level of green attitude, green strategy, and green governance. However, the operational aspects of Green BPM are poorly developed, and the resource consumption and emissions produced are measured, monitored, and utilized by only a limited number of SMEs. On aggregate, one SME of ten is positioned in Green BPM level 0, while two SMEs are observed to transition to level 1, five SMEs are positioned in Green BPM level 1, and two are observed to transition to level 2, while none are assessed to be in levels 2 or 3. Our analysis shows that the perceived benefits of Green BPM practices are mostly realized through cost reduction, better customer relations, improved competitiveness and profitability, and a better firm image. The pressures dominantly emanate from customers exerting pressure for retention and financial institutions. The dominant barriers are limited availability of time, lack of resources, expertise, and knowledge, high implementation costs, and bureaucracy. However, no pattern of common benefits, pressures, and barriers could be identified in the Green BPM levels. We observe that the barriers constitute hurdles but do not prevent the SMEs from taking further measures, while the benefits do motivate the owners to advance on Green BPM. We contribute to the existing research stream of business sustainability as well as BPM literature. Importantly, our study integrates two research fields to study the current level of Green BPM in SMEs through a newly developed Green BPM maturity model. Hence, this study provides an in-depth analysis of the implemented Green BPM factors and related forces that impact Green BPM in terms of benefits, pressures, and barriers to improve the level of business sustainability through business processes for SMEs. In addition, a set of guidelines are extracted to help SMEs in fostering their Green BPM efforts.

Declaration of funding

This research did not receive any specific grant from funding agencies in the public, commercial, or not-for-profit sectors.

Declaration of originality and consent

We declare that this research is not under consideration for publication elsewhere, that its publication is approved by all authors and tacitly or explicitly by the responsible authorities where the work was carried out, and that, if accepted, it will not be published elsewhere in the same form, in English or in any other language, including electronically without the written consent of the copyright holder.

CRediT authorship contribution statement

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Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Data availability

No data was used for the research described in the article.