

# What Are the Performance Indicators for Successful New Product Development Projects in Small and Medium-Sized Enterprises?\*

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## ABSTRACT

New product development (NPD) has become essential for many small and medium-sized enterprises (SMEs) to ensure their competitiveness and survival. However, NPD is fraught with pitfalls that can lead to project failure. To increase the likelihood of success, SMEs need to monitor the performance of their NPD projects using accurate indicators. The literature is underdeveloped when it comes to the indicators used by SMEs, with most research focusing on larger companies. Our research aims to fill this gap by taking a closer look at the indicators used by five Canadian SMEs that have successfully carried out NPD projects. Drawing on resource-based view theory, we identify the stages and activities carried out and the indicators used at different points in the NPD process of SMEs characterized by some resource constraints. Situation awareness theory helps to select quality criteria in the identification of indicators such as measurability. Our results show that a wide variety of indicators are used by SMEs to measure different dimensions of performance. Many of these indicators have not been previously identified in the literature.

**Keywords:** indicators, new product development process, performance dimensions, resource-based view theory, situation awareness theory, small and medium-sized enterprises (SMEs)

## QUELS SONT LES INDICATEURS DE PERFORMANCE POUR DES PROJETS DE DÉVELOPPEMENT DE NOUVEAUX PRODUITS RÉUSSIS DANS LES PME ?

## RÉSUMÉ

Le développement de nouveaux produits (DNP) est devenu, pour de nombreuses petites et moyennes entreprises (PME), une activité essentielle pour assurer leur compétitivité, voire leur survie. Toutefois, le DNP est empreint de difficultés de sorte que l'on observe de nombreux échecs. Pour augmenter les chances de réussite, les PME ont besoin surveiller la performance de leurs projets de DNP à l'aide d'indicateurs précis. Or, la

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littérature est relativement peu développée en ce qui a trait à ces indicateurs en PME, la plupart des recherches se concentrant sur les grandes entreprises. Notre recherche vise à combler cette lacune en examinant de plus près les indicateurs utilisés dans cinq PME canadiennes qui ont mené à bien des projets de DNP. En s'appuyant sur la théorie des ressources, nous avons identifié les étapes et les activités réalisées ainsi que les indicateurs utilisés à différents moments dans le processus de DNP des PME, caractérisées pas des contraintes de ressources. La théorie de la conscience de la situation a permis de cibler des critères de qualité dans l'identification des indicateurs, notamment la mesurabilité. Nos résultats montrent que les PME utilisent une diversité d'indicateurs qui mesurent différentes dimensions de la performance. Bon nombre de ces indicateurs n'ont pas été recensés auparavant dans la littérature.

**Mots-clés :** dimensions de la performance, indicateurs, petites et moyennes entreprises (PME), processus de développement de nouveaux produits, théorie de la conscience de la situation, théorie des ressources

## 1. INTRODUCTION

For many small and medium-sized enterprises (SMEs), new product development<sup>1</sup> (NPD) is essential to ensure their development, competitiveness, and survival. The uncertainty surrounding NPD, however, involves risk-taking and the commitment of significant resources that are sometimes difficult for SMEs to access (de Waal & Knott, 2019a). According to several researchers, failure rates for NPD projects range from 40% to 90%, with an average of 50% (Heidenreich & Handrich, 2014; Rhaïem & Amara, 2021). Bertheau and Garel (2015) estimate that only 20%–30% of projects show a positive return on the investments.

To ensure that limited SME resources are allocated to the most promising NPD projects, it is necessary to monitor their use (Bowers & Khorakian, 2014). By monitoring performance within the NPD process, managers can exert greater control over committed resources (Taipaleenmäki, 2014) to enable the achievement of varied goals, quickly redirect when mistakes are made, and reduce the risk of failure (Bedford et al., 2019; Munck et al., 2020). Proper performance monitoring requires the use of relevant indicators to support decision-making and to allocate resources more efficiently, promoting the performance of the NPD process (Dewangan & Godse, 2014; Hart et al., 2003; Markham & Lee, 2013). Markham and Lee (2013) and Munck et al. (2020) confirm the superior performance of companies that use NPD performance indicators. The lack of appropriate indicators, conversely, would contribute to inefficient management of a company's resources and lead to suboptimal decisions (Baines & Langfield-Smith, 2003).

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1. The OECD defines product innovation as “a new or improved good or service that differs significantly from the firm's previous goods or services and that has been introduced on the market” (OECD, 2018, p. 21). At the extremes of a novelty continuum, there is on the one hand radical innovation, which has a high degree of novelty and therefore uncertainty, and on the other hand incremental innovation, which consists of improvements made to an existing product and has less uncertainty (OECD, 2018). In this article, we use the term NPD, which, according to these definitions, consists of creating a new product that differs from those offered by a company and has a high degree of novelty.

Despite the importance of selecting and using appropriate performance indicators in NPD, current research is relatively silent on this issue in SMEs (Nappi & Kelly, 2022) and takes little account of recent changes in the way NPD project performance is measured (Dziallas & Blind, 2019). Some authors argue that there is a need to better understand the indicators used by companies that reflect and promote the success of NPD projects (Bukoye et al., 2022; Korhonen et al., 2023). This need was already pointed out 20 years ago by Carbonell-Foulquié et al. (2004) and Tzokas et al. (2004), who also criticized the lack of clarity of the proposed indicators.

SMEs differ from large companies in several ways, the most notable being the prominent role of owner-managers and their strong influence on the organization and its development (Newby et al., 2012). This influence is even more pronounced in strategic contexts such as NPD (Bowers & Khorakian, 2014). The owner-manager is recognized as having a leading role in determining an SME's objectives, which also influences the way it is managed (Newby et al., 2012; Raymond et al., 2013).

SMEs are known to not adequately measure NPD performance: the indicators used are incomplete and do not cover all relevant dimensions (de Waal & Knott, 2019b). In his study of start-ups, Meyssonier (2015) mentions that owner-managers build ad hoc tools that contain different indicators to measure their business performance. Taipaleenmäki (2014) observed the same situation among SMEs engaged in NPD: different indicators are used in an unstructured way, with little use of standardized models such as Kaplan and Norton's Balanced Scorecard. The decision to use their own indicators may be explained by the fact that SME managers want them to better meet their needs for, among other things, flexibility and agility. It may also be explained by the fact that the indicators proposed by researchers have characteristics that do not help managers in their choice: confusion and interchangeability of the terms used (metrics, indicators), a profusion of indicators that measure different aspects (innovation capacity, processes, results), and different dimensions of performance, as well as a lack of consistency and clarity in their formulation.

Therefore, it appears necessary to develop indicators that are tailored to the needs and peculiarities of SMEs to increase the success rate of their NPD projects (Bhuyian, 2011; Jiménez-Zarco et al., 2006; Nappi & Kelly, 2022). This task is further complicated by the fact that there is no universal NPD process within SMEs (Huang et al., 2002; Leithold et al., 2016) and that the processes followed by SMEs are rarely formalized (Bertrand & St-Pierre, 2018; de Waal & Knott, 2016, 2019a; Robbins & O'Gorman, 2016). To develop relevant indicators, it is essential to better understand the NPD process within SMEs as well as the information used. Our research with five Canadian SMEs successful in NPD, including interviews with nine of their managers, identifies the stages and activities that make up their NPD process and the indicators used to assess the relevance of pursuing the project during these different activities. This information makes it possible to enrich the indicators proposed by the literature and to develop, in a structured way, a list of indicators adapted to SMEs. Therefore, our research question is: What indicators are used within the stages and activities of the NPD process of successful, innovative SMEs?

Our article is organized as follows. Section 2 outlines the literature review and the theoretical background, followed by the methodology used to answer the research question in Section 3. Sections 4 and 5, respectively, present the results and the discussion, and Section 6 identifies the contributions of our research. Section 7 concludes with the research's limitations and potential avenues for further research.

## 2. LITERATURE REVIEW AND THEORETICAL BACKGROUND

In this section, the concepts of our research are defined—namely, performance, its dimensions and its measurement, and the indicators proposed by researchers to measure performance within the NPD process. Then, we present the resource-based view and the situation awareness theories that can help us understand the NPD process and performance indicators used in SMEs.

### Performance: Dimensions and Measurement

Performance is a multidimensional concept that can be measured in different ways (Dewangan & Godse, 2014; Lecoivre, 2017). Over the years, the term *performance* has evolved from a purely financial conception to a more global one integrating operational, organizational, social, and sustainable dimensions, making it possible to evaluate the achievement of various objectives that have been prioritized within companies (Bourne et al., 2003; Bremser & Barsky, 2004; Garengo et al., 2005; Kaplan & Norton, 1996). In NPD, three dimensions of performance are prioritized—financial, commercial, and operational/technical (Dziallas & Blind, 2019; Griffin & Page, 1993; Hart, 1993; Huang et al., 2004; Tzokas et al., 2004)—and are measured with the use of indicators.

An indicator is defined as information that helps an individual or a group steer the course of action toward the achievement of an objective or to evaluate its results (Lorino, 2011). This definition corresponds to the two distinct functions of an indicator in relation to the action: process and outcome (Lorino, 2003).

Outcome indicators measure the performance of an activity after its termination. Cooper (2011) suggests that performance should also be measured throughout the execution of the activity using process indicators. However, the author offers few examples of such indicators. Process indicators serve as checkpoints (go/no-go) when making decisions within the process (Carbonell-Foulquié et al., 2004). They prove to be a critical element of NPD project management (Cooper, 2011) and help improve the chances of project success (Tzokas et al., 2004) through corrections to activities and reallocation of resources when necessary. The need to monitor the performance of an NPD process is confirmed by Richtné et al. (2017), who indicate that the targeted indicators should continuously be evaluated and reassessed considering new information obtained during the process. For Munck et al. (2020), this justifies the use of financial and nonfinancial indicators depending on the activities of the NPD process and the tasks to be performed.

## Indicators Within the NPD Process

The NPD process is described as a series of stages, where each stage includes a set of activities and tasks necessary to advance a new product idea to commercialization (Cooper, 1990, 2008). The number of stages varies depending on the level of detail desired (Munck et al., 2020). For example, Feeney and Pierce (2018) identify seven stages; Akroyd and Maguire (2011) refer to the five stages of the process as modeled by Cooper (1990); Hertenstein and Platt (2000) propose four stages; and Ernst et al. (2010) use a three-stage process.

The best-known NPD process model is the stage-gate system (SGS) developed by Cooper (1990). It remains the most widely adopted NPD process in companies to this day (Cocchi et al., 2021). The SGS is both a conceptual and an operational model, beginning with a pre-stage of idea generation (ideation) and proceeding through five main stages: (1) preliminary assessment, (2) detailed analysis, (3) product development, (4) testing and validation, and (5) commercialization. These stages are then broken down into 13 activities,<sup>2</sup> which are themselves broken down into a series of tasks. The advantage of SGS is that the predetermined and structured stages of the process are completed (go/no-go) if the manager considers the objectives to have been met. This allows for tighter control over resources and quicker reaction to avoid waste or project failure (Adams et al., 2006; Jiménez-Zarco et al., 2006).

Although formalized NPD processes may be rare in SMEs (Bertrand & St-Pierre, 2018; de Waal & Knott, 2016, 2019a; Robbins & O’Gorman, 2016), they sometimes perform the stages prescribed in the SGS, as shown by Huang et al. (2002) in Australian SMEs and by Leithold et al. (2015) in Spanish SMEs. However, as these activities differ from one firm to another, the NPD process used in an SME should be described before identifying the indicators used (Jiménez-Zarco et al., 2006).

Indicators related to the financial dimension signal whether the business strategy and its implementation contribute to improving financial outcomes, such as profitability, growth, efficient use of assets, and shareholder value (Kaplan & Norton, 1996). This dimension refers to the financial gains made from selling new products on the market (Dziallas & Blind, 2019). Examples of such indicators are ROI and gross margin (Crossan & Apaydin, 2010).

The commercial dimension reveals how a business meets the expectations and needs of its clients. It plays a crucial role in the success of new products (Dziallas & Blind, 2019). In NPD, this dimension is measured through indicators related to the

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2. These activities are (1) idea generation and initial screening, (2) preliminary market assessment, (3) preliminary technical assessment, (4) detailed market analysis, (5) detailed technical and financial analysis, (6) product development, (7) product testing (internally), (8) product testing (by clients), (9) test market/sales trial, (10) trial production, (11) precommercialization analysis, (12) production start-up, and (13) commercialization.

market (share and size), client retention and satisfaction (Kaplan & Norton, 1996), purchase intention rate (Griffin & Page, 1993), share of new product sales (Hollenstein, 2003), and time to market (De Felice & Petrillo, 2013).

The operational/technical dimension incorporates indicators related to cycle time, product quality, employee skills, and productivity (Dewangan & Godse, 2014). Companies identify processes and competencies in which they must excel and define measures for each of them (Kaplan & Norton, 1992, 1996).

In reviewing the literature, we identify some indicators for the 13 SGS activities. These indicators come from authors (listed in Appendix 1), whether they have conducted a systematic review, a literature review, or an empirical study in SMEs or large enterprises. We also grouped them according to the three performance dimensions prioritized in NPD (Appendix 1). This compilation revealed that no indicators were proposed for some activities, such as product testing, sales trials, and production start-up. Conversely, many indicators were proposed for other activities, such as preliminary technical analysis, product development, trial production, and commercialization. Some indicators are specific to a single activity (e.g., productivity gain, for product development), while others are more universal (e.g., market share). Technical activities include more operational and technical indicators, while the commercial dimension is associated more with market-related activities and indicators. Financial indicators are found in detailed financial analysis, trial production, and commercialization, which are accompanied by checkpoints (gates) involving the achievement of financial objectives required to continue the project. The relevance of this list of indicators, as well as its shortcomings, are highlighted in our analysis of data from SMEs.

To understand the SMEs' behavior in NPD concerning their process and indicators used, we mobilize the resource-based view and the situation awareness theories.

## Resource-Based View Theory

In resource-based view theory, the performance of firms is assessed according to their resources and the conditions under which they are used to develop a competitive advantage (Barney, 1991). These resources are varied and include assets (money, equipment, technology), capabilities, processes, brand names, knowledge, and skills (Barney, 1991; Wernerfelt, 1984). Innovation, like the NPD, requires a significant amount of resources of various kinds (financial, technological, human) throughout the process, from ideation to commercialization (Bekono & Bekolo, 2020; de Waal & Knott, 2019b; Expósito & Sanchis-Llopis, 2019). However, SMEs are often subject to resource constraints. The lack of a skilled workforce and financial resources could be an important limitation to their capacity to innovate (Bekono & Bekolo, 2020; Pierre & Fernandez, 2018). Optimizing the use of these resources therefore becomes an essential issue for SMEs that wish to develop new products (Pierre & Fernandez, 2018).

Innovation requires specific skills and methods that, when lacking, can place the enterprise in a vulnerable situation and reduce its performance. A team with diversified



skills can better identify critical activities that may hinder the progress of the process and thus the success of NPD projects (Bertrand & St-Pierre, 2018). Furthermore, Hoque and James (2000) and Nobre (2001) show that the measurement of nonfinancial performance is relatively uncommon in smaller enterprises that have fewer human resources available. Balanced performance measurement, integrating financial and nonfinancial indicators, is more prevalent in large companies.

Due to the lack of sufficient and competent human resources, SMEs also tend not to measure NPD performance adequately (de Waal & Knott, 2019a). SMEs' managers play multiple roles at the same time (Ates et al., 2013) and this may limit the time available to them for monitoring NPD project performance (de Waal & Knott, 2019a). It is therefore important that they ensure that the indicators developed are clearly defined, enabling judicious and optimal use of human resources.

### **Situation Awareness: Quality Criteria for Indicators**

Situation awareness is described as the perception of the elements that make up the environment, the understanding of the situation (meaning), and the projection of future actions through decision-making to modify, if necessary, the course of a situation to achieve the stated objectives (Endsley, 1995; Wright et al., 2004). Situation awareness is influenced by, among other things, the individual's limited attention and information processing capacity. In a dynamic and complex environment, such as that of an innovative SME where managers and employees are dedicated to several tasks at the same time, it is difficult to perceive everything.

To overcome these limitations, certain conditions can be attributed to indicators (Endsley, 1995; Lorino, 2011). Presenting information according to each objective and highlighting critical elements facilitate the decision-making process and help to determine whether other objectives should be put forward. The development of automatisms and routines, as well as the filtering of information, empower the actor and require little attention, which can reduce mistakes and increase success (Endsley, 1995; Lorino, 2011). This allows for specifying the quality criteria that can be attributed to indicators.

Indicators must be clear, measurable, relevant, useful, consistent with the activity to be evaluated, and linked to an objective, and they must highlight critical elements (Endsley, 1995; Lorino, 2003, 2011). Making sure that the indicators identified meet these quality criteria helps to reduce the differences in interpretation between individuals and facilitates the transition from one stage (activity) to the next in the NPD process.

In sum, from a resource-based view perspective, the availability of resources (e.g., human and financial) can influence the indicators used by SMEs: insufficient resources could prevent the measurement of some indicators. Meanwhile, the situation awareness theory helps explain how scarce human resources in SMEs may lead to the development and utilization of indicators meeting quality criteria. Managers must be able to correctly and rapidly interpret the information transmitted by different indicators with respect to quality criteria to make good decisions throughout the NPD process.

### 3. METHODOLOGY

The limited knowledge surrounding performance monitoring throughout the NPD process in the context of SMEs gives our study an exploratory aspect. We adopt a flexible research design (Robson, 2011) through multiple case studies (Yin, 2017). This choice is also justified by the fact that the NPD process is not universal among SMEs and that it is necessary to document it well before identifying and interpreting the indicators used and those that are absent and could be useful.

#### Case Selection Criteria and Recruitment

To facilitate comparisons between cases (Yin, 2017), we identified two critical case selection criteria. First, the selected SMEs were required to have successfully developed and commercialized a new product in the 2 years prior to the research, so that all process stages, activities, and indicators could be accessed. Second, SMEs were required to have a dedicated NPD team consisting of at least two people to ensure that there was a structure (including process and indicators) and that NPD is not improvised by the owner-manager, which can be the case in SMEs.

We were able to identify SMEs that met these criteria using a directory of Quebec, Canada, manufacturing SMEs indicating their industry, size, and type of products as well as the region and markets served. We targeted 12 SMEs that were close to our region to facilitate their access, and we contacted them by phone to inquire about their interest. Recruiting SMEs was a challenge, as some respondents were reluctant to provide us with data deemed sensitive about their innovation and performance practices, but 5 of them agreed to participate in our research.

#### Overview of the Studied SMEs

The five SMEs selected operate in a dynamic environment, and their activities are growing. They are well aware of the needs of their clients and work in codevelopment with them and subcontractors in developing new product ideas. Their NPD success rate is high: 80%–100% of the new products they developed have been commercialized. Their new products can be classified as major innovations as they have a high degree of novelty and contribute to the development of a new market. Table 1 presents some of the business characteristics as well as the profile of the managers we met in each SME.

To reinforce the reliability and quality of the information collected, we solicited two respondents per SME for the interview: the leader of the NPD team and an internal manager. Only one respondent was interviewed in SME 4: the owner also held the position of R&D manager, which made it possible to collect all the desired data.

#### Data Collection and Analysis

The three data collection and analysis steps performed are summarized in Table 2.



TABLE 1  
Overview of SMEs studied

	SME 1	SME 2	SME 3	SME 4	SME 5
<b>SME data:</b>					
Revenues (Can\$ millions)	<10	20–30	20–30	10–20	>40
Number of employees	<100	100–150	150–200	<100	250–300
Industry	Food equipment	Agriculture machinery	Specialized equipment	Specialized equipment	Injection molding
<b>NPD team leader (first respondent):</b>					
Title	General Manager	CEO	General Manager	R&D Director	VP of Engineering
Shareholder (yes/no)	Yes	Yes	No	Yes	No
Years of NPD experience	20	9	19	9	20
Years of experience in the company	6	13	14	9	2
Field of expertise	Management	Sales	Engineering	Engineering	Plastic technician
<b>Second respondent:</b>					
Title	R&D manager	Project manager	Quality manager	—	Project manager
Field of expertise	Engineering	Engineering	Engineering technician	—	Engineering technician

Notes: To preserve the anonymity of the five SMEs, their names have been replaced by SME 1 to SME 5.

**TABLE 2**  
Description of steps carried out for data collection

Steps	Objectives	People involved
1. Web-based questionnaire	Description of the NPD process, SME context, and respondent profile	Team leader (first respondent)
2. In-person semistructured interview	Validation of the NPD process and documentation of the indicators used	Team leader and team member
3. Validation (exchange of documents and phone discussions)	Validation of the relevance of the list of indicators developed	Team leader (first respondent)

The questionnaire<sup>3</sup> (Step 1) consisted of closed and open-ended questions that presented every stage and activity of Cooper's SGS model. The respondents were asked to check off the stages and activities that were carried out in their company and to add, if necessary, information concerning their process (e.g., tasks) not listed in the model. The questionnaire, transmitted online to the first respondent via a secure link, was completed with information about the company's profile (size, strategy, markets) and the respondent's profile (experience, education, expertise). Once the data were collected, we analyzed them to make an initial mapping of the NPD process in each of the SMEs and to customize the interview scheme for the second step of data collection.

Semistructured interviews (Step 2) lasting approximately 90 min were conducted with the two respondents jointly in each SME. Three sections made up this interview: (1) description of the SME; (2) description of the NPD project, process, objectives and indicators used within the process activities; and (3) organization, management, and structure of the NPD process (resources, skills, collaborations). During the interview, several internal company documents (over 200 pages in total) were provided by the respondents to directly address some of their statements about the indicators used. These documents included lists of indicators, dashboards, task checklists, evaluation criteria, and production or project tracking reports. We used the interview and the secondary documents data to validate and complete the initial mapping of the NPD process and to document the indicators used, including those that allowed for progress from one stage of the process to the next (sending a signal of continuity). A few challenges arose concerning the clarification of the terminology used by the respondents and the measurement of indicators to ensure mutual understanding between the respondents and the researcher. With the respondents' consent, the interviews (501 min of recording) were recorded and transcribed.

In the final step (Step 3), an NPD process map, based on the stages and activities most often identified from the five SMEs, was sent to the participants. It was

3. Researchers interested in the data collection tools (questionnaire and interview outline) are invited to communicate with the corresponding author.

accompanied by a second file presenting a list of indicators compiled from the information extracted from academic literature and those obtained from the SMEs. The classification of the indicators used by the SMEs was complicated by the fact that the same indicators could be used in different activities and under more than one performance dimension. This validation step ensured that the proposed classification of indicators was appropriate for the respondents and that the indicators were well understood and clearly formulated. It also contributed to the richness of the data collected. A sample file for the idea generation and initial screening activity is presented in Appendix 2.

The SGS model, mentioned earlier, was used as a conceptual basis both for the development of the collection tools and for the analysis process. The data collected (questionnaire, interviews, secondary documents) in each SME were analyzed individually (intra-case analysis) before proceeding to inter-case analyses (Paillé & Mucchielli, 2008). The intra-case analysis generated memos for each SME on the themes captured. Various themes were preidentified and linked to the research question, the interview questions, and the theories mobilized—for example, NPD process, indicators, objectives pursued, resources needed, and collaboration. Some themes also emerged based on the terms and words used by the respondents—for example, risk management. The case memos were then compared based on the themes to identify similarities and differences and to facilitate inter-case analysis (Miles & Huberman, 2003).

Specifically, the data on the indicators collected from the interview and the secondary documents were summarized by SME (intra-case) and then compared across the five SMEs (inter-case). This enabled common indicators to be grouped and differences between them to be identified. For each SME, the indicators were classified according to the NPD process activity and by relevant performance dimension under each of these activities, enabling an interesting cross-referencing between prioritized dimensions of performance and activities carried out in the NPD process of SMEs. Throughout the analysis, the literature was consulted to provide explanations for the differences observed between SMEs.

## 4. RESULTS

Our study aimed to document the indicators used by SMEs that have successfully carried out NPD projects to better understand the information used to progress through the NPD process. The results obtained are presented in this section. In the following, we discuss the results in relation with the literature and the theories mobilized, shedding helpful light on explanations that may lead to an understanding of whether or not an indicator is used in SMEs.

### NPD Process in SMEs

In general, the NPD process in the studied SMEs is broken down into stages and activities that are themselves detailed in a series of tasks. In addition, some gates provide a signal as to whether or not specified objectives have been met and the process can move to subsequent stages and activities. Their NPD processes are formalized, well documented,

and adapted to their needs for flexibility and agility by limiting the number of tasks performed.

The need to get to market quickly makes the process agile and dynamic, with feedback loops between the preliminary assessment and detailed analysis stages and between the product development and testing stages. These particularities of the NPD process in the studied SMEs lead to the use of a variety of indicators depending on the stages and activities defined.

### Indicators Used in the NPD Process of SMEs

SMEs use indicators through their NPD process that cover three performance dimensions: financial, technical/operational, and commercial. The results obtained were compiled into three lists of indicators, presented in Tables 3–5. These tables show the indicators used in the five SMEs for each of their process activities, detailed by dimension (financial, operational, and commercial). Five gates are identified and included in the tables. The numbers (1, 2, 3, 4, and 5) refer to the five SMEs. On the left-hand side of the tables, the indicators collected from the literature (Appendix 1) are in bold type. The indicators used in SMEs for a specific activity, but not identified in the literature, are presented in shaded cells. N/A shows where an indicator appears for an activity in the literature but is not used by the studied SMEs. The presentation of the tables emphasizes the indicators that are more common and those that are different in the NPD process of the five SMEs. Several observations are made following the presentation of Tables 3–5.

For the financial dimension (Table 3), the product cost and the profitability (gross margin) of the new product and the project are the indicators that are most frequently used. According to the literature, the product cost is generally assessed during the technical and detailed financial analysis activity, whereas for the studied SMEs, it is measured earlier, at the idea generation stage. Indicators related to cost calculations and financial resources are more detailed in SMEs if we compare them with those presented in the literature: cost variances, subcontractor costs, R&D investments, and the ratio of raw material on sales are examples of indicators used in the process. SMEs' limited financial resources may explain the need to assess and control their utilization along the process to avoid waste. In addition, these indicators make it possible to measure, among other things, ROI and payback period.

Financial indicators are more prevalent in idea generation, preliminary technical assessment, detailed technical and financial analysis, product development and testing, trial production, precommercialization analysis, and commercialization. Most of these activities are associated with gates that require validation of the achievement of objectives such as profitability, which in turn requires the calculation of these financial indicators. One activity (detailed market analysis) has no financial indicators, while two other activities (preliminary market assessment and production start-up) have only one indicator each. No financial indicators have been identified in the literature for these two activities either. These activities are more associated with the commercial dimension, and few, if any, indicators are useful and relevant to use in the financial dimension.

TABLE 3  
Indicators of financial dimension used in NPD process of studied SMEs

Indicators	Idea generation and initial screen (1)	Preliminary market assessment (2)	Preliminary technical assessment (3)	Detailed market analysis (4)	Detailed technical and financial analysis (5)	Product development, testing and sales trial (6, 7, 8, 9)	Trial production (10)	Precommercialization analysis (11)	Production start-up (12)	Commercialization (13)
<b>Financial resources</b>	1, 3, 4, 5		1, 2, 3, 4				N/A			
Prioritization index (score)	2, 4, 5									
<b>Product cost</b>	1, 3, 4		1, 2, 3, 4, 5		1, 2, 3, 4, 5	1, 2, 3, 4, 5	1, 2, 3, 4, 5	1, 2, 3, 4, 5	1, 2, 3, 4, 5	
Total project cost										
Cost variances from estimates	1, 3, 4				1, 2			4		
Subcontractor cost					3					
<b>Actual expenses versus budget</b>										
<b>Cost reduction</b>			2				2, 3, 4, 5			
Cost increase							1, 3, 4			
Ratio RM (labor) / product cost	1		1		1	1, 3, 4	1, 3, 4	1		
Ratio RM (labor) cost / sales						1, 2		3		
<b>Product gross margin</b>	1, 2, 3, 4, 5		1, 3, 4		1, 2, 3, 4, 5	1, 3, 4		1, 2		1, 2, 3, 4
<b>Profitability (total)</b>					1, 2, 3, 4, 5	1, 3, 4		1, 2, 3, 4, 5		1, 2, 3, 4, 5
<b>Percentage gross margin on NP (achievement)</b>										1, 2, 3, 4
Product selling price		2, 5			4, 5	3, 4		2		
Engineering costs (time)			3			3		3		
<b>Real estate (asset) investments</b>			3, 4, 5		1, 2, 3, 4, 5		2, 3			
<b>R&amp;D investments</b>			3, 4		1, 4, 5	5	5			
<b>Recruitment cost</b>			3							
<b>Development cost</b>			4, 5			2, 4, 5	2, 4			4, 5
Maintenance cost (for clients)			3							
Patent and license cost			2, 5		5		2, 5			5
Tooling cost							4			
Correction cost										
R&D tax credits							2			5
<b>Number of licences sold</b>										5
<b>ROI</b>			2		2, 5					5
<b>Payback period</b>			2, 3		2, 3, 5					2, 4, 5
Net present value (NPV)					2					2, 3, 5
<b>Costs / benefits</b>					2					
Sensitivity analysis: revenue, margins					5					
<b>Break-even point (sales, time)</b>			4		4			N/A		

**Notes:** The table shows the indicators used in the five SMEs for each of their process activities in the financial dimension. Numbers 1 through 5 in each row indicate SME 1 through SME 5 (where indicators are not found for process activities, the cells are blank). Five gates are identified. The indicators collected from the literature (Appendix 1) are in bold type. The indicators used in SMEs for a specific activity but not identified in the literature are presented in shaded cells. N/A denotes where an indicator appears for an activity in the literature but is not used by the studied SMEs.

Several indicators identified in SMEs are not suggested by the literature (shaded cells in Table 3). SMEs seem to use more detailed financial information than the literature suggests. Furthermore, research sometimes suggests an indicator (e.g., payback period or profitability) that is linked to a specific activity, which the SMEs studied use both for the specified activity and other activities. In addition, certain indicators associated with specific activities in the literature (e.g., financial resources during the trial production activity or break-even point in the precommercialization analysis activity) are used by the SMEs studied, but they are used during other activities. Similarly, some indicators identified by previous research are not used by any of the SMEs studied: R&D intensity or economic value added are examples. These indicators seem either irrelevant or too costly to develop and measure. All these results suggest that SMEs do not hesitate to adopt financial indicators according to the information they deem necessary to carry out their process efficiently.

The technical and operational issues are important in NPD, given the high degree of product novelty, and they lead the studied SMEs to use several operational indicators (Table 4). In particular, they use indicators related to the new product's quality and compliance with the technical requirements. Timeframes are also considered to ensure that the new product reaches the market before a competitor. Technical risks are constantly assessed, based on a series of questions, and actions are taken to reduce them if necessary. The hours allocated to an NPD project (development, production, actual hours/planned hours) are tracked throughout the process. Keeping track of these indicators is crucial as SMEs operate with limited human resources (and hiring difficulties due to labor shortages in certain fields). They need to control the use of their resources and allocate working hours to the most promising NPD projects. However, the use of working hours as an indicator is not identified in the literature.

Technical and operational indicators are more present under the activities of preliminary technical assessment, detailed technical and financial analysis, product development and testing, and commercialization. This seems normal and consistent as these activities are related to the technical issues of the new product being developed and the results that need to be assessed. The gates that accompany these activities cover the achievement of technical requirements, project monitoring, prototype manufacturing, evaluation of the necessity to continue testing, and client satisfaction.

In line with the literature, no technical and operational indicators are used in the SMEs for activities linked to market assessment. The tasks related to these activities (e.g., validation of customer interest, analysis of the competition or conception of a market plan) do not require consideration of technical issues and indicators. Even if operational issues are related to the production start-up activity, the literature does not suggest technical indicators for this specific activity. However, the studied SMEs assess the new product performance during this activity, before beginning the commercialization activity, to make sure that the new product complies with the technical requirements. When



TABLE 4  
Indicators of technical and operational dimension used in NPD process of studied SMEs

Indicators	Idea generation and initial screen <div>Gate 1</div> (1)	Preliminary market assessment (2)	Preliminary technical assessment <div>Gate 2</div> (3)	Detailed market analysis <div>Gate 2</div> (4)	Detailed technical and financial analysis <div>Gate 3</div> (5)	Product development, testing, and sales trial (6, 7, 8, 9)	Trial production (10)	Precommercialization analysis <div>Gate 4</div> (11)	Production start-up <div>Gate 5</div> (12)	Commercialization <div>Gate 5</div> (13)
Available technical resources (hours)	1, 3, 4, 5		1, 2, 3, 4				N/A			
Timeframe of project (number of weeks, months)	1				2, 3		2			
Product performance (quality, compliance)			1, 3		1, 2, 3, 5	1, 3, 4	1, 3, 4		1, 2, 3, 4, 5	
Technical risks			1, 2, 3, 4, 5		1, 2, 3, 4, 5	1, 3, 4, 5	5			1, 3
Timeframe before production			1, 2, 4, 5		1, 3, 4					
Development process timeframe						2, 3, 4				
Implementation timeframe							1, 2, 3, 4	2		3, 5
Compliance with deadlines										2, 3, 5
Development hours	4		2, 4		1, 4, 5	2, 3, 5	2, 4, 5			2, 3
Production hours			2, 3, 4		1, 4, 5	2, 3, 5	2, 4, 5			2, 3
Actual hours / planned hours					2		2			
Hours for completed product development							2, 3, 4, 5			
Number or percentage time overruns						2, 3, 5				
Productivity gain						3				
Manufacturing process efficiency										
Implementation at the production level (rate)						1, 3, 4	1, 2, 3, 4			
Production rate						5	N/A	5		3, 4
Sales / labor hours							3			3
Number of completed products						1, 2, 3, 4, 5				
Number of products in development						1, 2, 3, 4, 5				
Number of design changes						5				

**Notes:** The table shows the indicators used in the five SMEs for each of their process activities in the technical/operational dimension. Numbers 1 through 5 in each row indicate SME 1 through SME 5 (where indicators are not found for process activities, the cells are blank). Five gates are identified. The indicators collected from the literature (Appendix 1) are in bold type. The indicators used in SMEs for a specific activity but not identified in the literature are presented in shaded cells. N/A denotes where an indicator appears for an activity in the literature but is not used by the studied SMEs.

necessary, SMEs measure this indicator again in the process to ensure the quality of the new product and its compliance with requirements before launch.

Some operational indicators proposed by the literature are not used by the SMEs. Indicators such as frequency of changes, peer review of the design work, and turnover rate of the different resources are not identified in the five SMEs studied. The information related to these indicators is either not relevant to managers or the information needed to calculate them is not available or requires too many resources.

The commercial dimension (Table 5) is considered from the beginning of the process in the studied SMEs. They assess the expected sales volume during the idea generation and initial screen activity, which is earlier than what is proposed in the literature. This indicator is then updated according to the data obtained in the subsequent commercial activities. The expected sales volume is used, among other things, in the calculation of profitability and to send a signal at the first gate. The number of potential clients is assessed at the beginning of the process as it provides an early indication of market and sales potential before the commercialization stage: “The goal is to identify clients before commercialization because it’s difficult to commercialize new products” (VP Eng., SME 5).

The number of potential clients is often used to replace the market share and size indicators, which are generally not calculated in some SMEs because the data is either unavailable or too expensive to obtain. In the case of two SMEs (SME 2 and SME 5), the resources and data available sometimes make it possible to calculate these two indicators at the detailed market analysis activity. However, as one of the respondents mentions, “It’s hard to get market data because we don’t have the resources of large enterprises” (CEO, SME 2).

The time to market is measured in the detailed market analysis for all five SMEs, which count on speed to occupy the market with their new products. Market issues are particularly important in the final stage of commercialization. The managers evaluate the increase in sales related to the new product and the level of client satisfaction. Also, it is at the commercialization stage that the success rate (or the failure rate) is calculated. It is measured by the number of products developed and commercialized compared to the total number of products developed.

Commercial indicators are more present under activities related to preliminary and detailed market analysis, precommercialization analysis, and commercialization. These results show consistency between the indicators used, the activities, and the objectives pursued at the various gates. Two activities included in the SMEs’ NPD process are not associated with any commercial indicators: preliminary technical assessment and production start-up. These two activities are more related to operational issues. According to the literature, seven activities (rather than two) have no commercial indicators. It appears that SMEs need to measure commercial issues from the beginning of the process, during the idea generation activity, to make sure that the new product idea has good market potential, and also during the product development and testing activities, to assess if the

TABLE 5  
Indicators of commercial dimension used in NPD process of studied SMEs

Indicators	Idea generation and initial screen (1)	Preliminary market assessment (2)	Preliminary technical assessment (3)	Detailed market analysis (4)	Detailed technical and financial analysis (5)	Product development, testing, and sales trial (6, 7, 8, 9)	Production trial (10)	Precommercialization analysis (11)	Production start-up (12)	Commercialization (13)
Market potential (units)	1, 3, 4, 5	2, 4, 5								
Expected sales volume	1, 3, 4, 5	1, 2, 3, 4				1, 3		1, 2, 3, 4		2, 3, 4
Increase in sales										1, 2, 4
Number and names of clients (recurring sales potential)		1, 2, 4		5						
Commercial expenses				5						N/A
Time to market		2		1, 2, 3, 4, 5			1	2		
Launching speed								2		
Market share		N/A		2, 5						N/A
Market size		N/A		2, 5						N/A
Sales growth potential					2, 3, 4					
Percentage of successful NP launches										1, 2, 4
Success rate										1, 2, 3, 4, 5
Failure rate						N/A				1, 2, 3, 4, 5
Number of products marketed per year										5
Client satisfaction										1, 2, 3, 4, 5
Qualitative requirements of the client		3					1, 2			
Benefits for clients		2, 3			5					
Risks for clients										5
Percentage of new clients										1, 5
Percentage of client retention										1, 2

**Notes:** The table shows the indicators used in the five SMEs for each of their process activities in the commercial dimension. Numbers 1 through 5 in each row indicate SME 1 through SME 5 (where indicators are not found for process activities, the cells are blank). Five gates are identified. The indicators collected from the literature (Appendix 1) are in bold type. The indicators used in SMEs for a specific activity but not identified in the literature are presented in shaded cells. N/A denotes where an indicator appears for an activity in the literature but is not used by the studied SMEs.

investment is likely to offer commercial benefits. The SMEs also use commercial indicators that are not suggested in the literature, such as the number and names of potential clients.

In addition, some commercial indicators suggested by the literature, such as time to market compared to the industry or business (market) intelligence analysis, are not used in any of the five SMEs. According to our analysis, they either do not have access to this information (it is not available or too expensive to get) or their employees do not have the skills required to perform that kind of intelligence analysis. Moreover, their proximity to customers, with some SMEs even codeveloping their new product with customers, leads SMEs to use the information obtained from them to measure the sales growth potential, the number of clients, and the commercial risks, for example.

Overall, the activities that generate the most indicators in all dimensions are idea generation and screening, preliminary technical assessment, and detailed technical and financial analysis. From product development to precommercialization analysis, technical and financial issues are given priority, hence the high number of indicators used. At the commercialization stage and at the final gate, the need to confirm the project's profitability, client acceptance, and the new product's entry into the market also requires many indicators. Some indicators are recurrent and adapted to different activities given their nature. This is the case, for example, for product cost, development hours, and time to market. As the project progresses, their update reveals new information that is critical to the continuation of the process. The data collected show that many indicators are consistent with what is presented in the literature, but others are specific to the needs of each SME. Moreover, some indicators are used in different activities, and thus at different times in the process, than what has been observed by other researchers. This highlights the flexibility of SMEs when it comes to measuring NPD performance.

Although the indicators used in the SMEs may differ from those proposed by scholars, the activities that are associated with the greatest number of indicators are the same in both cases. This may be due to the greater ease of assessing performance under these activities or it may reflect the greater importance given to these activities both in research and in practice.

## 5. DISCUSSION

In this section, the results obtained are discussed on the basis of the theories mobilized, providing some explanations about the indicators used (or not used) in SMEs. In addition, quality criteria in the determination of indicators are essential in ensuring a common interpretation of indicators between managers in the conduct of NPD process activities.

Using resource-based theory, we can argue that, among the five SMEs, sufficient financial resources and a variety of skills promote the deployment and development of an adequate NPD process, including numerous indicators. The presence of a competent and experienced NPD team allows the SMEs to quickly adjust their NPD process when the situation deviates from what is desired. As indicated by Bertrand and St-Pierre (2018), a diversity of skills enhances the success of NPD projects in SMEs as the team can better

identify the diversity of possible risks and monitor critical activities. Since the lack of skills and financial resources can be an important limitation for innovation in SMEs (Bekono & Bekolo, 2020; Pierre & Fernandez, 2018), we noted in our sample that sufficient resources can support the effective deployment of an NPD process and indicators based on three performance dimensions.

One of the distinctions between the SMEs stems from the number of indicators used and the tools that document them, which are more elaborate for some. The availability of resources and skills and more decentralized structures can explain these differences between SMEs. For example, SME 2, SME 4, and SME 5 all use a summary of the results of the idea prioritization indexes and a dashboard for every project. They also use, as does SME 3, a summary of the criteria and indicators for the various gates. These SMEs have more employees and members in the NPD team, which leads them to elaborate more on the tools that provide the indicators if we compare them to SME 1.

In addition, the experience of the respondents (data collected in the questionnaire) seems to influence the use of certain indicators (Tables 3–5). Strong experience in NPD, for instance, may sometimes compensate for the lack of resources to obtain the information needed to formally calculate an indicator. This can also allow for a reduction in the number of indicators used, as experienced managers can evaluate the performance of a project even without systematic results based on a series of indicators. Strong experience in NPD may also lead managers to underutilize some indicators (e.g., risk assessment) or to estimate the results of an indicator based on experience with similar projects (e.g., payback period) instead of making a formal assessment with specific data. Indeed, in a context of uncertainty and scarcity of information such as that of an NPD project, SME managers tend to rely on their past experience in similar projects to make sense of a situation and maintain an accelerated pace of decision-making. They tend to use shortcuts (heuristics) and ignore some information to decide faster, more economically, and more accurately (Gigerenzer & Gaissmaier, 2011). This leads them to make less use of sophisticated indicators, preferring simple but high-quality ones. Despite heuristics traditionally being linked with cognitive limitations, studies like Maitland and Sammartino (2015) have highlighted their potential strength in decision-making in dynamic and uncertain contexts.

The areas of expertise of the respondents (primarily management and engineering) may also influence the indicators they use and consider relevant. Since engineers work more on technical issues, they seem to use more operational and technical indicators, as we observed in our SMEs, such as those related to product performance (e.g., quality). Also, the SMEs' close relationships with their main clients reduce the uncertainty surrounding commercialization, which tends to reduce the use of indicators from the commercial dimension. These findings are similar to those of de Waal and Knott (2019a), who observe a lack of variety in the indicators as well as poor coverage of the performance dimensions in the SMEs they studied. The experience and areas of expertise of managers, as well as proximity to clients, are rarely considered in empirical studies on performance measurement (in SMEs or elsewhere).

Furthermore, indicators that meet quality criteria are necessary to monitor performance during the NPD process, especially when managers are responsible for several tasks that limit their available attention and time (Ates et al., 2013). The quality of the indicators facilitates decision-making and the efficient use of (sometimes limited) resources, improving the chance of success for NPD projects. Indicators that meet quality criteria represent an interesting contribution to reducing possible interpretation discrepancies between individuals (Endsley, 1995; Lorino, 2011). A better understanding of the indicators through their clear formulation, measurability, relevance, usefulness, consistency with the activity being evaluated, and linkage to an objective can mark out the interpretations and reduce erroneous decisions. This also ensures that an indicator that is unknown or little used by some individuals can be included, as it has been validated by the respondents of our study. This also fills a need expressed by some researchers about the development of indicators aligned with the NPD process and better adapted to the context of SMEs (Adams et al., 2006; Bhuyian, 2011; Dziallas & Blind, 2019; Jiménez-Zarco et al., 2006; Nappi & Kelly, 2022) that can promote NPD project success (Bukoye et al., 2022; Korhonen et al., 2023). Finally, this addresses the lack of clarity in the formulation of indicators noted by Carbonell-Foulquié et al. (2004) and Tzokas et al. (2004) and clarifies the terminology used, therefore limiting the confusion we noted in the literature on the topic.

Our results show that some indicators used by SMEs are not identified in the literature, which contributes to a better understanding of NPD performance measurement in these small firms. As for Munck et al. (2020), we were able to highlight the use of financial and nonfinancial information whose relevance varies according to the activities included in the NPD process. The management of uncertainty and the validation of the achievement of objectives (profitability, in particular) are essential in the first stages of the NPD process, which are characterized by high risks and limited availability of information required to make decisions, as observed by Munck et al. (2020). This leads, as we have seen in the studied SMEs, to the use of nonfinancial indicators such as timeframes, development hours, and market potential.

Hart et al. (2003) show that the financial dimension is important during the detailed technical and financial analysis and after the product is launched on the market (commercialization), which is also confirmed by Munck et al. (2020) and Carbonell-Foulquié et al. (2004). Our results show that indicators from the financial dimension are also prominent during product development, testing, and production trials. The five SMEs studied consider financial aspects earlier in the process than what is mentioned in the literature. They need to control the cost, gross margin, and investments required before authorizing the production of the new product. The limited financial resources of SMEs may explain why they assess and control their utilization along the process to avoid waste. The main reason for advocating financial measures, according to Dziallas and Blind (2019), is that they are quantitative and more readily available. For example, R&D expenditures are usually accounted for in companies that innovate since this makes it easier to control and monitor activities (Adams et al., 2006).



According to Carbonell-Foulquié et al. (2004), the indicators that measure client acceptance and satisfaction with the new product are particularly used during the commercialization stage. This helps SMEs to know if their new product concept is adopted by clients and if its launch is likely to be successful. Our results show that the SMEs mostly use commercial indicators in activities related to preliminary and detailed market analyses, precommercialization analysis, and commercialization. These activities are also accompanied by gates that require the validation of client satisfaction. Commercial indicators are thus more numerous during the commercialization stage, which is consistent with the literature.

Dziallas and Blind (2019) show that indicators measuring the operation and technical dimension are more frequent during the design and product development stages. The evaluation of the technical dimension is critical to approve the new product concept and its prototype (Carbonell-Foulquié et al., 2004). As for Hart et al. (2003), they find that this dimension of performance is more frequently evaluated during product and sales trials. Thus, the more the process progresses, the more indicators concern the operational/technical dimension (Dziallas & Blind, 2019). The five SMEs encountered use indicators related to technical resources, timeframes, product performance, and development hours from the beginning and throughout the process. However, they use a higher number of operational indicators during product development, testing, and validation, as well as trial production activities.

For SMEs that have limited resources, it is crucial to obtain this type of information before beginning the product development stage. Among other things, it allows them to determine the advantage of the new product for clients (performance, quality, superiority), which helps SMEs develop a competitive advantage. As soon as the product enters the prototyping and testing phase, it becomes important for managers to assess its quality, compliance with technical requirements, and risks. The increased availability of data as the process progresses makes it possible to calculate these indicators and decide whether to continue, to reevaluate, or to stop the project (Dziallas & Blind, 2019).

Considering the three dimensions of performance for the identification of indicators fills a gap identified by de Waal and Knott (2019b). According to them, the indicators to be monitored in SMEs are incomplete and do not assess all aspects of NPD project performance. Also, our study offers new indicators for some activities (e.g., trial production) where the literature did not offer any. We were able to identify indicators at the beginning of the process that complement those proposed by scholars.

In this regard, our study fills some needs identified in the literature, such as documenting various and multidimensional indicators integrated in the NPD process. To our knowledge, this is one of the only studies that has managed to document, from empirical data, the indicators used by SMEs for different activities while simultaneously classifying them by performance dimension within each of these activities. We have succeeded in accessing confidential data from five successful, innovative SMEs. This enriches our understanding of the NPD process in SMEs, but more importantly, of the indicators that can ensure success through close monitoring of performance and the use of various resources. This monitoring is more effective as the diversity of indicators used increases

(various dimensions, financial and nonfinancial). However, our results contrast with those of Hertenstein and Platt (2000), who suggest that managers place more emphasis on non-financial performance measurement, and with those of Davila et al. (2004), who, on the contrary, reveal a preference for financial measurement on the part of managers. They also diverge from those of Munck et al. (2020), who mention that nonfinancial measurement is more frequent at the beginning of the process and financial measurement toward the end of it.

## 6. THEORETICAL AND MANAGERIAL CONTRIBUTIONS

Our study provides an interesting theoretical contribution to the knowledge in the field of NPD process and performance measurement in SMEs. Contrary to what is suggested in the literature, we show that some SMEs use NPD processes that are structured and formalized while being adapted to their need for flexibility and to their limited resources. We also document numerous indicators used within the NPD process activities and according to three dimensions of performance: financial, operational, and commercial. Some of the indicators identified are absent from those proposed by the authors consulted. Furthermore, we note that the results obtained are sensitive to certain variables specific to the SME environment. These elements shape the indicators used and the emphasis placed on them in the NPD process. One of the influences is the proximity to the clients, which can make certain commercial indicators less relevant. The resources and skills available in the SMEs also help to establish a process and indicators adapted to their needs. Although resource limitations may constrain the establishment of more elaborate indicators, such as market size and share, managers use complementary indicators (e.g., expected sales volume, number of potential clients) to compensate for a lack of market information. Managers also rely on their experience to make an informal assessment of certain indicators (e.g., payback period) in the absence of accurate data.

Our study also presents relevant and useful managerial contributions. It describes the NPD process of SMEs and documents various indicators classified under the different process activities and performance dimensions in NPD. This can help to support the success of NPD projects in SMEs. Knowing that they are sometimes faced with limited resources, lists of relevant indicators that meet quality criteria can be used, measured, and interpreted appropriately by managers, and the advisors who accompany them, to enhance their success rate in innovation. The description of the stages and activities carried out in the process of successful SMEs makes it possible to better plan the necessary resources, and the identification of relevant indicators for each stage/activity enhances control over these resources and their reallocation, if necessary. Companies can therefore choose the performance indicators to adopt, using the lists proposed by our study from the literature review and empirical data, which cover the three performance dimensions of NPD under each of the process activities.

## 7. CONCLUSION, LIMITATIONS, AND FUTURE RESEARCH

The turbulence of the competitive environment increases the pressure on SMEs to more actively engage in innovation activities. However, these activities are a source of

uncertainty and failure that can be detrimental to their survival. One way to reduce the risk of failure is to monitor the use of resources allocated to these activities through precise performance indicators of various kinds.

The data collected from five manufacturing innovative Canadian SMEs enable a better understanding of their NPD process and activities, and the identification of indicators that promote the efficient allocation of their resources. These indicators, both financial and non-financial, cover the financial, operational, and commercial dimensions of performance and vary according to the activities executed in the process. Our results enrich those presented in the few studies conducted within SMEs by covering a wide spectrum of activities necessary for the successful development and commercialization of new products.

Taking into consideration the particular nature of SMEs, their operations, and their managers, which modulate their needs in terms of process and performance measurement, we suggest indicators that are relevant to their context. The data collected are, however, contingent on the limited number of SMEs studied, which limits the scope of the results and restricts any attempt to generalize the conclusions to the entire SME population. Our findings do, however, offer interesting research perspectives regarding the use of formalized NPD processes in smaller companies for the creation of performance monitoring tools relevant to the activities executed and the resources used. From this perspective, it could be interesting to further examine the influence of the SME context on NPD projects. The analyzed SMEs are in close contact with a limited number of clients, so the uncertainty about the acceptability of the new product is relatively low. They also have a high success rate in NPD and are led by experienced managers who prioritize innovation as a development strategy. This specific context may influence the number of indicators used and the activities carried out in these SMEs; many then meet their needs with more informal control for certain activities in their NPD process. A higher degree of uncertainty about the acceptability of the new product may require a more formalized and detailed control and process, and a greater number of (more sophisticated) indicators, even in cases where project managers are highly experienced in NPD. Conducted in another context, with other types of SMEs and managers, or with a larger number of cases, this study might have led to different results. For example, do SMEs that have experienced NPD project failures (a new product was not commercialized) use the same indicators as the SMEs studied or different ones? Also, when SME managers exercise more informal control along the NPD process, is it compulsory to use performance indicators in NPD projects?

Finally, the study of these various practices in the context of upheaval emanating from economic, health, or ecological crises, among others, could influence the critical indicators to be monitored. How does this context change the performance dimensions prioritized and the indicators considered in the NPD process for SMEs? How will the current ecological tensions eventually affect the importance given to the quantity of resources used, leading SMEs to prioritize the environmental dimension in measuring NPD performance? Will the three dimensions generally associated with NPD performance still be enough to reflect the challenges of responsible consumption? These questions provide avenues for researchers to better understand how SMEs can innovate successfully.

APPENDIX 1: INDICATORS PROPOSED IN THE LITERATURE TO MEASURE PERFORMANCE WITHIN NPD PROCESS ACTIVITIES

Panel A: Financial indicators													
Indicators	Activities												
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)
Available financial resources	x <sup>3</sup>		x <sup>1, 4, 11</sup>							x <sup>11</sup>			
Product cost					x <sup>3</sup>					x <sup>2, 7</sup>	x <sup>2, 7</sup>		
Actual expenses versus budget										x <sup>1</sup>			
Cost reduction										x <sup>6</sup>			
Cost increase							x <sup>2, 10</sup>			x <sup>2</sup>			
Product gross margin					x <sup>1, 9, 10</sup>								
Profitability (total)					x <sup>1, 9, 10</sup>								
Achievement of gross margin											x <sup>8</sup>		x <sup>8</sup>
Percentage gross margin on NP													x <sup>5, 9, 10</sup>
Percentage of sales by product (last 3 to 5 years)													x <sup>2, 4, 5, 7, 8, 9</sup>
Real estate (asset) investments			x <sup>1, 4, 11</sup>		x <sup>2</sup>					x <sup>4, 5</sup>			
R&D investments			x <sup>1, 4, 11</sup>		x <sup>2</sup>					x <sup>4, 5</sup>			
Recruitment cost			x <sup>2</sup>										x <sup>2</sup>
Development cost						x <sup>4, 7</sup>				x <sup>4, 5</sup>			
Development cost / revenue						x <sup>8</sup>				x <sup>4, 5</sup>			
R&D intensity (R&D investments / sales)	x <sup>1, 3</sup>				x <sup>2</sup>								
Number of licences sold													
ROI					x <sup>1, 2, 3, 4, 9, 10</sup>								x <sup>2, 5, 8, 9, 10</sup>
Payback period					x <sup>4</sup>								x <sup>8</sup>
Costs / benefits					x <sup>3</sup>								
Break-even point					x <sup>9, 10</sup>								
Sales to reach breakeven											x <sup>7, 9, 10</sup>		
Time required to reach breakeven											x <sup>7, 9, 10</sup>		
Economic value added													x <sup>7</sup>
Increase in value added (market value of the product compared to cost (including capital))													x <sup>2</sup>
R&D expenses / value added													x <sup>2</sup>
Value added / number of employees													x <sup>2</sup>

(The table is continued on the next page.)

(continued)

Panel B: Operational indicators													
Indicators	Activities												
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)
Available technical resources (hours)	x <sup>3</sup>		x <sup>1,4,11</sup>							x <sup>11</sup>			
Turnover rate of the different resources			x <sup>1</sup>		x <sup>3</sup>								
Product performance (quality, compliance)			x <sup>9,10</sup>			x <sup>11</sup>				x <sup>2,5,9,10,11</sup>			
Technical risks			x <sup>9,10</sup>		x <sup>9,10</sup>	x <sup>9,10</sup>							
Timeframe before production			x <sup>9,10</sup>										
Development process timeframe						x <sup>4</sup>							
Implementation timeframe (introduction)										x <sup>1,2</sup>	x <sup>5</sup>		
Compliance with deadlines													x <sup>1,9,10</sup>
Efficiency of product introduction													x <sup>1</sup>
Hours for completed product development										x <sup>2</sup>			
Number or percentage time overruns							x <sup>2,10</sup>						
Hours required for review										x <sup>2</sup>			
Percentage of technical, design, and research personnel			x <sup>2</sup>										
Number of designers / number of employees			x <sup>7</sup>										
Number of teams assigned to problem-solving			x <sup>2</sup>										
Number of team meetings										x <sup>3</sup>			
Savings attributable to each worker			x <sup>2</sup>										
Productivity gain						x <sup>2</sup>							
Manufacturing process efficiency						x <sup>4</sup>				x <sup>3</sup>			
Percentage of the first design that meets the needs						x <sup>7</sup>							
Percentage of new product features						x <sup>7</sup>							
Implementation at the production level													
Efficiency of the design team						x <sup>7</sup>	x <sup>1</sup>			x <sup>7</sup>			
Peer review of the design work						x <sup>7</sup>							
Number of change requests						x <sup>8</sup>							
Number of completed products						x <sup>7</sup>							x <sup>1</sup>
Number of products in development						x <sup>7</sup>							
Number of design changes						x <sup>7</sup>							
Frequency of changes						x <sup>7</sup>							
Number of design-related awards						x <sup>8</sup>							
Degree of change in product specifications		x <sup>1,2</sup>											
Number of new ideas generated		x <sup>1</sup>					x <sup>1</sup>						
Rate of idea (or product) adoption													
Number of new products announced						x <sup>2</sup>							
Number of abandoned projects		x <sup>4</sup>											

(The table is continued on the next page.)

(continued)

Panel C: Commercial indicators													
Indicators	Activities												
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)
Market potential (units)		x <sup>10</sup>											
Expected sales volume		x <sup>11</sup>									x <sup>11</sup>		x <sup>4</sup>
Increase in sales													x <sup>2, 4, 5, 6, 7, 8, 9, 10</sup>
Achievement of revenue targets													x <sup>5, 9, 10, 11</sup>
Sales versus forecasts													x <sup>8</sup>
Percentage of sales to new clients													x <sup>7</sup>
Potential to increase clients													x <sup>4</sup>
Commercial expenses													x <sup>2</sup>
Market share		x <sup>10</sup>		x <sup>4, 11</sup>									x <sup>2, 4, 5, 6, 7, 9, 10</sup>
Market size		x <sup>4, 11</sup>		x <sup>4, 11</sup>									x <sup>4</sup>
Time to market													
Time to market compared to the industry											x <sup>2, 7</sup>		
Launching speed											x <sup>4, 5</sup>		x <sup>2, 8, 9, 10</sup>
Analysis of marketing resources (number, amount)				x <sup>4</sup>							x <sup>1</sup>		
Sales growth potential					x <sup>9, 10</sup>								x <sup>4</sup>
Percentage of successful NP launches													x <sup>8</sup>
Success rate													x <sup>2</sup>
Failure rate							x <sup>2</sup>						x <sup>8</sup>
Number of products marketed per year													x <sup>2, 4, 5, 7, 8, 9, 10, 11</sup>
Client satisfaction													x <sup>4</sup>
Percentage of new clients													x <sup>4</sup>
Percentage of client retention													
Business (market) intelligence analysis											x <sup>1</sup>		

**Notes:** If an indicator is not used by the SMEs in our sample, it appears in italics. The authors who mention an indicator under the different activities are indicated in the table with footnotes as follows: (1) Crossan and Apaydin (2010) (systematic review); (2) Tidd (2001), Tidd et al. (2006); (3) Adams et al. (2006) (systematic review); (4) Jiménez-Zarco et al. (2006) (literature review); (5) Huang et al. (2004) (empirical—SME); (6) Industry Canada (2013) (empirical—SME); (7) Hertenstein and Platt (2000) (empirical—industrial design—all sizes of businesses); (8) Cooper (2011); (9) Griffin and Page (1993) (empirical—all types of businesses); (10) Hart et al. (2003) (empirical—all types of businesses); and (11) Carbonell-Foulquié et al. (2004) (empirical—all types of businesses).



APPENDIX 2: FILE TO BE COMPLETED FOR VALIDATION OF RELEVANCE OF INDICATORS (EXAMPLE)

Indicators used in the NPD process in the studied SMEs and from literature are identified with an x.

Purpose: To validate the relevance\* of the identified indicators to the stages and activities of the NPD process (check if relevant to your company).

Idea generation and initial screen			
	SMEs studied	From the literature**	Check if applicable
Financial	Available financial resources	x	x <input type="checkbox"/>
	Prioritization index (score) (rating to target promising ideas)	x	<input type="checkbox"/>
	Product cost	x	<input type="checkbox"/>
	Total project cost	x	<input type="checkbox"/>
	Ratio RM (labor) / product cost	x	<input type="checkbox"/>
	Product gross margin	x	<input type="checkbox"/>
Operational	R&D intensity (R&D investments / sales)	x	<input type="checkbox"/>
	Available technical resources (hours)	x	x <input type="checkbox"/>
	Timeframe (number of weeks, months) (general)	x	<input type="checkbox"/>
	Development hours	x	<input type="checkbox"/>
	Number of new ideas generated	x	<input type="checkbox"/>
	Rate of idea (or product) adoption	x	<input type="checkbox"/>
Commercial	Number of abandoned projects		x <input type="checkbox"/>
	Expected sales volume	x	<input type="checkbox"/>
	Risk assessment (financial-operational-commercial)	x	<input type="checkbox"/>

Notes: \*Relevance: Quality of what is relevant, logical, perfectly appropriate for measuring the performance of the identified activity. \*\*Based on other studies in the field.

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