



Management accounting and new product development: a systematic literature review and future research directions

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Abstract

This paper systematically reviews the existing literature at the crossroads of management accounting and new product development. At present, the accumulated knowledge on this topic is fragmented. Different research settings, diverse research focuses, and the use of different research methods are amongst the main reasons for the existing fragmentation and lack of an overall, conceptually coherent view of the knowledge gained on the management accounting phenomenon in new product development environments. As a response to the current knowledge fragmentation, the purpose of this paper is to consolidate existing evidence, provide an overview of the literature's state-of-the-art, and propose paths for its future development. As a result of the systematisation attempt, this paper recognises the threefold identity of management accounting research in new product development and proposes a conceptual framework that collocates existing contributions along a research spectrum that gradually shifts the focus from the more technical-oriented aspects of management accounting to the more sociological-oriented aspects. Accordingly, this paper identifies the following research paths and systematise their relative contributions: (1) management accounting techniques and calculations; (2) management accounting information types and roles; (3) management accountants' involvement and roles in new product development environments. Besides allowing the systematisation of previous investigations, this paper's three research avenues provide a 'lighthouse' to those who, in future, aim to contribute to the current debate and knowledge creation at the intersection of management accounting and new product development. In this regard, the final part of the paper advances nine research propositions that emanate from the literature review and outlines a research agenda with directions for future research.

Keywords Management accounting · New product development · Systematic literature review · R&D process

1 Introduction

New product development (NPD) is a pivotal source of competitive advantage for and a central organisational activity of many companies (e.g. Davila, 2000; Christner & Strömsten, 2015; Janka & Guenther 2018). Following basic and applied research activities, the NPD activity interacts with them to form the wider research and development (R&D) process (Suomala & Jokioinen, 2003; Matthews 1991; Batty, 1988; Chiesa, 2001; Chiesa & Frattini, 2007; Chiesa et al., 2008; Chiesa et al., 2009; Davila, 2000). Consisting of a cross-functional effort that engages different participants and organisational domains (Feeney & Pierce, 2016; Feeney & Pierce, 2018), the NPD process in the management accounting (MA) literature is defined as a structured, multi-phased, and iterative process with the objective to transform an idea into a product (Davila, 2000). Early stage NPD activities, also known as the ‘fuzzy front-end’ phase of NPD (Kim & Wilemon, 2002), form the uncertain, dynamic, but fundamental stage of the NPD process that begins when a business opportunity is first deemed worthy of further consideration, exploration and assessment, and ends when a firm decides to invest in the idea and launch the project (Kim & Wilemon, 2002), thus recognising it as a new source of value creation (Davila et al., 2009). After this phase, the NPD project usually goes through a process of constant growth that likely ends in the commercialisation of the new product and the concretion of value creation. The level and type of uncertainty that affect this process vary as the process evolves.¹ This, together with the strategy and organisational structure of the NPD team, influences the use of MA and shapes the design of MA practices in the specific NPD setting (Nixon, 1998; Davila, 2000).

The scientific discussion of MA in NPD has its roots in the long-standing relationship between control and innovation (Davila et al., 2009). Scholars adopted different views of the role that management control systems (MCS) in general, but also MA in particular, play in a context permeated by creativity and uncertainty. The dilemma that has occupied researchers over the years is whether innovation requires control and how this control can effectively and fruitfully be combined with uncertain and creative activities. Two views emerged on the issue (Davila et al., 2009). On the one hand, it has been argued that accounting’s coercive and hence negative impact on creativity constrains innovation (e.g. Abernethy & Brownell 1997).² Innovation takes advantage of exceptions, uncertainties, unexpected opportunities, creativity, and instability. Unsurprisingly, “tools designed to eliminate variation and control routine activities” are considered to “have little role in these settings” (Davila et al., 2009: 282). On the other hand, it has been argued that accounting enables innovation since it provides a set of management tools and practices that produce information capable of reducing uncertainty (Davila, 2000) while facilitating the coordination

¹ In this article, following Davila (2000) who draws on the concept of uncertainty introduced by Galbraith (1973), uncertainty refers to “the difference between the amount of information required to performing a task and the amount of information already possessed by the organization” (Galbraith, 1973: 5).

² This view draws on the traditional and primitive view of MCS (Anthony, 1965), which is well represented by the thermostat metaphor. The actual temperature (output measured) is compared with the desired temperature (defined objective) and, in the case of any deviations from the desired temperature, the thermostat (MCS) quickly reduces unintended variations (Davila et al., 2009).

of interdependent tasks and actors (e.g. Nixon, 1998; Jørgensen & Messner, 2010; Adler & Chen 2011). This debate has evolved over time, together with the phasing out of the view that considered accounting as a stifling source of innovation (Davila & Wouters, 2007). The literature currently agrees on accounting's positive effects on creativity and innovation (e.g. Davila & Foster 2007; Davila et al., 2009; Moll, 2015; Major et al., 2018). Yet, research on this topic remains fragmented and this fragmentation, which has characterised the evolution of accounting research on NPD over the years, makes it difficult to integrate different contributions and provide a conceptually coherent overview of them (Moll, 2015). There are various reasons why the literature reached this indistinct point. The first is of a general nature, being linked to a widespread research trend. Currently, researchers as well as journal reviewers and editors are more inclined to look for gaps that need filling by new (eventually minor) contributions than to pause and reflect on existing knowledge and to accord proper weight to research efforts in this area (Moll, 2015). As a result, researchers show a general lack of interest in determining how their work is similar to or different from the work of others, apart from conducting this task as a way to find a gap to be filled with the findings of their on-going research projects. Then, specific research-related reasons also explain the current state of the literature. Existing studies focus on different contexts, be they organisational (top management *versus* the project team), of concern to particular industrial fields (e.g. medicine, semiconductors, automotive), or related to the company's life cycle (start-ups *versus* established companies). Researchers have used different research methods to conduct their investigations (i.e. surveys, case studies, experimental methods) and, in designing their research, they have sometimes either adopted a broader (studying MCS as a whole) or a narrower focus (focusing on and exploring specific practices) (Moll, 2015). However, to advance scientific enquiry, there is a need to consider the literature's state of the art. Therefore, the fragmentation must be eliminated or reduced by analysing the various findings in combination. This paper aims to overcome the fragmentation that affects existing accounting research on NPD by employing the systematic literature review (SLR) method to analyse and structure the field in a methodical manner. Therefore, this article offers a comprehensive and meaningful synthesis of the current state of research on the MA phenomenon in NPD by focusing on the specific crossroads of MA and NPD, instead of considering MCS and innovation in general (e.g. Lill et al., 2020; Müller-Stewens et al., 2020).

To achieve this objective, the paper is structured as follows. Section 2 describes the methodology and the design of the research. Section 3 proposes a conceptual framework for MA research in NPD. This framework is used to discuss how MA in NPD has been investigated in the retrieved literature, as well as to systematically organise existing knowledge and stimulate future research. Three complementary streams of research emerge from the proposed framework, recognising the threefold identity of MA research in NPD. Section 4 discusses the findings of the literature review, formulates nine research propositions and provides directions for future research. Finally, section 5 closes the paper with concluding comments.

2 Methodology

To contend with the fragmentation of knowledge that characterises MA research in NPD, Snyder (2019) identifies the literature review as an effective research method. A properly designed literature review operates as a tool (Tranfield et al., 2003) to consolidate and develop an existing body of research, as it can overcome knowledge segmentation resulting from different research endeavours conducted on the same topic at different times, within different contexts, and according to different perspectives. Depending on the form of the selected literature review to craft the review article, it is possible to achieve a systematic result (Snyder, 2019). When choosing the SLR method as the preferred research method, it is necessary to embrace the specific principles and guidelines concerning both the conduct of the review (e.g. Tranfield et al., 2003) and the writing of the article (e.g. Liberati et al., 2009) along the entire research process. The end result is a collection and logical synthesis of existing evidence which, in a transparent and replicable manner (Tranfield et al., 2003), provides a state-of-the-art understanding of the topic, an outline of the current research gaps, a roadmap for future research and, overall, a contribution to the development of a particular discipline and domain (Webster & Watson, 2002; Snyder, 2019; Paul & Criado, 2020). Accordingly, for the present study, a domain-based SLR (Palmatier et al., 2018; Paul & Criado, 2020) was planned, conducted and reported in accordance with the available conceptions of the design, analysis, and reporting of existing studies (Webster & Watson, 2002; Tranfield et al., 2003; Liberati et al., 2009; Snyder, 2019; Paul & Criado, 2020). As illustrated hereafter, the Scopus and Business Source Complete electronic databases were searched without any time restrictions, in accordance with a search protocol defined before the start of the review process. The decision not to limit the literature review's time period of interest was aligned with the purpose of the review itself, namely to overcome the fragmentation of MA research in NPD in order to offer a "*theoretically coherent account of it*" (Moll, 2015: 9). This requires collecting all the existing and accessible evidence of the MA phenomenon in NPD. Table 1 and 2 – which present the final outcomes of an iterative and preparatory set of scoping studies aimed at exploring and, thereafter, through a trial-and-error process, identifying the most powerful keywords and effective keyword combinations – report the sequence of key terms used to search the two databases in seven and two different rounds, respectively.

We used the criteria outlined in Table 3 to include retrieved studies in the pool of articles of potential interest for the literature review. We excluded studies not compliant with these criteria.

To ensure, for review purposes, the relevance of the studies included in the pool of articles of interest based on the application the inclusion criteria (Table 3), we manually evaluated the retrieved articles' titles, abstracts and – when the title and abstract were insufficient to ascertain the importance of the study – full texts. This procedure also allowed the elimination of non-relevant articles or duplicates. Based on the same rationale and to increase the literature review's inclusiveness, we manually added

Table 1 Keywords and strings used to search the Scopus database

Scopus	
1	“product development” AND “management accounting” OR “managerial accounting”
2	“product development” AND accounting
3	“product development” AND “accounting data”
4	“R&D project*” AND “management accounting” OR “managerial accounting”
5	“R&D project*” AND accounting
6	“product development” AND accountant*
7	“R&D project*” AND accountant*

The difference between the string *Scopus 2* and the string *Scopus 3* is that when using the string *Scopus 3* “accounting data” was searched in *all fields* of the articles (i.e., not only in the title, abstract, and key words of the articles but also in their main text).

The asterisk at the end of a search word allowed searching for both singular and plural (i.e., project or projects, accountant or accountants).

Table 2 Keywords and strings used to search the Business Source Complete database

Business Source Complete	
1	“managerial accounting” AND “new product development”
2	“managerial accounting” AND “research & development”

Table 3 Criteria used to include retrieved studies in the literature review

Inclusion criteria	
Criterion a	Business, Management, and Accounting fields
Criterion b	Academic article, article in press, editorial, review
Criterion c	English language

articles deemed relevant but not retrieved on the basis of the SLR criteria.³ Fig. 1 depicts the flow diagram of the overall search and studies’ selection process.⁴

Each of the included studies was provided with a data-extraction form containing general information (title, author, year of publication, source), specific information (article’s content, research method, method theory if any) and specific comments (core contributions, emerging themes, links to other studies). This data-extraction sheet served as the data-repository and as the origin of the ensuing conceptualised literature review framework and literature review.

³ Studies were considered relevant and therefore eligible for the literature review if they reported evidence of the MA phenomenon in NPD. These studies were identified by scanning the reference lists of the articles retrieved with the SLR, by searching Google Scholar, and by exploiting the authors’ prior knowledge of relevant papers on the topic of interest.

⁴ The described protocol and search were performed three times, in 2019, 2020 and 2021, respectively. The 2019 search results were updated by including relevant results of the 2020 and 2021 searches, based on relevant studies published between 2019 and 2021. Over time, the search protocol was also refined and perfected.

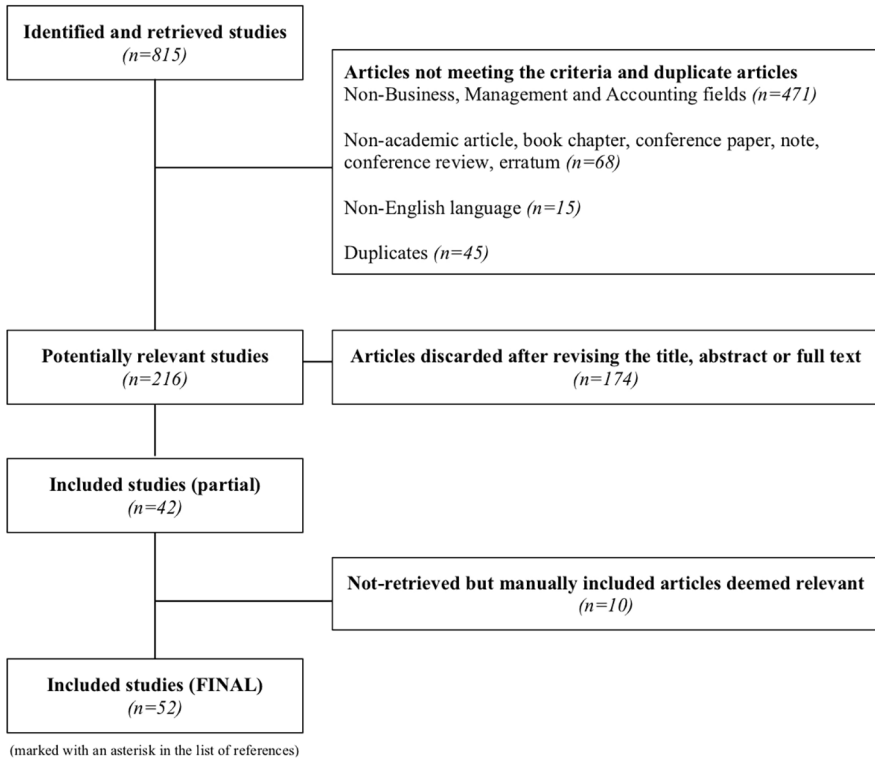


Fig. 1 Flow diagram of the selection of studies

3 Literature review framework

Domain-based SLR articles⁵ are classified into categories, one of which is the framework-based review article (Paul & Criado, 2020). A domain-based review article is framework based if the authors develop it by using either an in-house-developed framework or an existing framework. In MA research, the use of a simple framework to organise existing studies has proved to be an effective approach to gain insights into the current state of knowledge and to promote knowledge progress (e.g. Davila & Wouters, 2007; Messner 2016). Relying on this evidence and embracing the proposal to organize literature reviews into cohesive narratives based on a coherent conceptual structuring of the reviewed topic (Bem, 1995; Webster & Watson, 2002), we used the framework-based approach to develop this review article.

After considering extant research, it was clear that three sets of studies represent the main aspects which were the focus of previous endeavours. Firstly, studies that explored MA information in NPD and the role that this information might have

⁵ An SLR article can be domain, theory, or method based (Paul & Criado, 2020). It is a domain-based article if it reviews, synthesizes, and extends a body of literature in the same substantive domain (Palmatier et al., 2018).

played in NPD projects. Secondly, studies that examined the means of producing this information and therefore focused on particular MA practices and calculations in the NPD context. Thirdly, studies that explored the role of management accountants in NPD settings and that examined the form and degree of their involvement in NPD activities. The extent to which these studies engaged with a specific investigative perspective varied from study to study and these perspectives, in the same study, often combined with one another. However, a fundamental part of the literature review's reporting process is to find emerging themes across the core contributions and to link these themes across different studies (Tranfield et al., 2003). Accordingly, this article proposes a conceptual framework that draws on the mentioned patterns recognised in the literature. The framework manifests in a threefold scheme that explicitly indicates complementary but different research paths to organise existing studies and inspire future research:⁶ 'MA techniques and calculations' (e.g. Davila & Wouters, 2004; Wouters & Morales, 2014; Stadtherr & Wouters, 2021), 'MA information types and roles' (e.g. Mouritsen et al., 2009; Janssen et al., 2011), and 'management accountants' involvement and roles' (e.g. Rabino, 2001; Hughes & Pierce, 2006; Lee & Wang, 2020). This threefold scheme is intersected by a successive twofold categorisation of existing research that qualifies existing studies according to their nature which – following Baldvinsdottir et al. (2010) who recognise that the real-world nature of the MA discipline stems from the harmonious combination of its technical and social aspects – is accordingly defined as 'more technical' or 'more sociological'. In this work, the research that focuses on MA practice in NPD, highlighting the technical features and capabilities of accounting information and accounting tools, is considered more technical-oriented (+T) research. By contrast, the research that focuses on the role of MA and investigates the effects of its presence and use within an NPD context, and which analyses its sociological implications for NPD's participants, is considered more sociological-oriented (+S) research. The proposed literature review framework, incorporating this intersection, appears as shown in Table 4.

The adjective 'more' (+) is used because MA is both a technical phenomenon and a social practice (Baldvinsdottir et al., 2010; Leotta, 2016). As a result, it can never be only technical oriented or only sociological oriented. It always involves a mix of the technical side and the human side. MA information is precisely collocated in the middle of this technical-sociological spectrum since it represents the outcome of technical-human integration into the accounting practice. Moreover, as it will appear from the literature review, the meaning embedded in the outcome of MA tools, namely MA information, has relevance both on the technical side and the sociological side of the

Table 4 A framework for MA research in NPD

MA in NPD: the proposed research framework	
Management accounting techniques and calculations	+ T
Management accounting information types and roles	T / S
Management accountants' involvement and roles	+ S

⁶ For the three identified research paths, examples of publications that primarily deal with each one of them are listed in brackets.

MA phenomenon in NPD. MA information resulting from the implementation of MA practices serves the technical purpose of conducting calculations and analyses during NPD while supporting decision making, but it also serves the sociological purpose of connecting NPD participants during NPD activities. The latter purpose concerns the interaction of people with MA and, thus, it also concerns the role of MA in the construction of human beings and social interactions (Nørreklit et al., 2017) in NPD environments. The ensuing sections compose the delineated framework and adopt a narrative approach⁷ to the synthesis and presentation of the literature review's results. By doing so, according to the proposed conceptual structure, light is shed on the MA phenomenon in NPD in its entirety.

4 Findings

Using the SLR protocol, the body of literature was restricted to 52 articles (see Appendix A for a descriptive analysis). After outlining the scheme of the proposed literature review framework, the results of the literature review are presented in this section. The reporting process shows a gradual progression from the more technical-oriented aspects to the more sociological-oriented aspects, covering the entire technical-sociological spectrum of the MA phenomenon in NPD.

4.1 Management accounting techniques and calculations in new product development

4.1.1 Management accounting presence: from accounting thinking to advanced calculations

The literature on MA in NPD reports on the forms of practice and the roles these forms of practice can play in the NPD process. The manifestation types of the MA practice adopted to measure and manage NPD activities vary extensively and encompass multiple approaches and purposes (Nixon, 1998; Davila, 2000; Hertenstein & Platt, 2000; Davila & Wouters, 2007; Ferreira et al., 2010; Carlsson-Wall & Kraus, 2015; Wouters & Morales, 2014; Wouters et al., 2016). Taipaleenmäki (2014) refers to this phenomenon by describing the variant modes of MA presence in NPD. Based on an explorative multi-organisation case study, he reports that MA in NPD ranges from total absence to the full use of the most advanced (company-specific) MA techniques. When MA is absent, it is often the result of a decision not to use financial controls in

⁷ The narrative approach to synthesis in review papers is criticised when these papers lack a solid, underlying research design. This is not the case when an SLR search protocol is employed (Palmatier et al., 2018). In this regard, a narrative approach is a type of research synthesis that aligns with the final goal of the review: through the theoretical synthesis of knowledge, providing collective insights – obtained from a range of different studies – into a field that academics and practitioners refer to when pursuing a reliable knowledge base (Tranfield et al., 2003; Moen, 2006) considers a narrative as a meaningful unit (of analysis) that serves the purpose of creating experience-based order and supporting people in finding practical solutions for the problems they face. In this study, work experience is represented by earlier papers on MA in NPD, and narrative on it serves the purpose of creating order from previous research.

a flexible, innovative context permeated by an engineering-oriented organisational culture, or it may be due to a lack of dedicated personnel. In other situations, characterised by an MA presence, MA manifests in several different forms. The use of MA concepts and MA thinking without MA calculation implementation is the softest manifestation of an MA presence documented by the author. In this variant mode, which we could refer to as '*MA as a mindset*', MA is present as a thinking exercise that increases the NPD team's business-orientation and financial consciousness by bringing the financial perspective into the NPD domain. For instance, if Activity-Based Costing (ABC) thinking is adopted, the theory associated with the practice of ABC is used to understand the cost implications of additional internal activities that might be required to meet different customers' specific requests. As another example, the use of an Activity-Based Management (ABM) thinking approach can encourage the development team to find and remove non-value-adding activities from the NPD project in progress (Taipaleenmäki, 2014).

In Nixon (1998), the existence of variant modes of MA practice in NPD is associated with time. Accordingly, MA practices evolve over time, from limited and soft forms with a strategic orientation at the fuzzy front-end phase of NPD, to specific, structured and detailed forms with an operational orientation at the later stages of the NPD process. Nixon (1998) reports a case where the role of MA practices is limited when first evaluating a new project proposal during the NPD's concept development phase, this evaluation being primarily concerned with vague assessments of the value of opportunities associated with the NPD project compared to the cost of doing nothing, that is, not undertaking the project. After building a prototype of the new product, MA calculations become more focused, structured, and detailed. The NPD opportunity is evaluated through accurate cash flow statements and detailed contribution margin analyses. This may require the preparation of different cost statements with different informative purposes and the implementation of advanced MA practices. Nevertheless, according to Nixon (1998), the softest form of an MA presence found by Taipaleenmäki (2014), namely the use of MA concepts, remains fundamental all along the process, irrespective of its development stage. He concludes that MA concepts form an important part of the NPD team's communicative practice as they ensure openness and collaboration among the team members. Thus, as Davila (2000) notes, the occasional but prevalent interpretation of MA systems as practices that only convey financial data must be broadened to include different kinds of possible manifestations and outcomes. Depending on the type of uncertainty facing managers and the phase of the NPD process, different combinations of financial and non-financial practices can be useful for NPD purposes (Davila, 2000; Hertenstein & Platt, 2000; Janssen et al., 2011). In this study, following Davila (2000), MA practices are broadly intended to be sources of both financial and non-financial information that "*are used to close the gap between the information required to perform a task and the amount of information already possessed*" (Davila, 2000: 387). We refer to MA practices that provide financial information as '*financial MA practices*' and to MA practices that provide non-financial information as '*non-financial MA practices*'.

4.1.2 Financial management accounting practices

The analysis of the financial consequences of decisions taken during the NPD process supports the NPD initiative and prevents failures. MA practices are appropriate tools to reduce uncertainty and communicate in advance, that is, before decisions are made, the likely outcomes of these decisions from a financial standpoint (Leotta et al., 2020). When a new product is designed, alternative product concepts are investigated (Anderson & Sedatole, 1998) and trade-offs between the performance, functionality and costs of these new concepts are evaluated (Wouters & Morales, 2014), with the goal of contributing to the company's value creation process. Accordingly, in this section, financial MA accounting practices are divided into two groups: cost management and estimation, and value creation measurement.

4.1.2.1 Cost management and estimation The first NPD step consists of defining the product concept and suggesting a range of product architectures that meet customers' requirements. "*Costs are designed into the product*" (Davila & Wouters, 2007: 833), affecting the manufacturer's product costs and the future product owners' financial performance (Hertenstein & Platt, 2000). The analysis and management of costs during the early phases of NPD are therefore a priority (Hertenstein & Platt, 2000). Accordingly, ex-ante cost modelling, also known as design-accompanying calculations (Mueller, 2009), and cost management methods are relevant practices in NPD (Labro, 2004; Davila & Wouters, 2007).⁸ Target Costing (TC) (Ansari et al., 2006; Burrows & Chenhall, 2012) and cost estimation techniques (e.g. Ben-Arieh & Qian, 2003) are useful practices to select product architectures that meet design specifications in a cost-effective way (Anderson & Sedatole, 1998). TC constrains the range of product architectures by setting a target (or allowable) manufacturing cost given the targeted price, profit and functionality specifications of the planned product. Recent developments show that its scope can also be extended to include targets for R&D costs and production investments besides manufacturing cost targets (Stadtherr & Wouters, 2021). Cost estimation techniques serve the purpose of deriving cost estimates for alternative product architectures (Anderson & Sedatole, 1998). They can be used as stand-alone practices or in combination with TC. In the latter case, the target cost assessed through TC is used as a benchmark to evaluate cost estimates made during the later stages of the NPD process (Hertenstein & Platt, 2000). Cost estimation methods vary in type and complexity, ranging from cost tables and engineering rules of thumb (linking design characteristics to product costs) to more advanced analytical techniques (Ben-Arieh & Qian, 2003), which can take

⁸ Wouters and Morales (2014) and Wouters et al. (2016) structurally reviewed 15 methods for cost management in NPD with the objective of providing descriptions and explanations of these practices in various literatures, namely, the MA literature (Wouters & Morales, 2014) and the Innovation and Operations Management (IOM) literature (Wouters et al., 2016). Since showing all results of these two literature searches (Wouters & Morales, 2014; Wouters et al., 2016) would exceed the scope of the present article, this section refers to the mentioned papers. What follows focuses on reviewing the literature on MA practices as retrieved by applying the methodology outlined in Sect. 2. By doing so, this article touches on several practices described in Wouters and Morales (2014) and Wouters et al. (2016), but also extends beyond them.

the form of process modelling and ABC calculations (Sandström & Toivanen, 2002; Tornberg et al., 2002; Ben-Arieh & Qian, 2003). Regardless of the cost estimation method employed, both the possibility of relying on the company's historical database and employee expertise are crucial elements when performing the estimation task (Nixon, 1998). According to a survey administered to a group of NPD engineers (Tornberg et al., 2002), cost estimation models should be simple at first sight, but they should also enable users to obtain more detailed information if needed. Besides, these models should be easy to use and should allow real-time information reception. If engineers are provided with cost-implication feedback the moment a variant design is generated, they can immediately analyse, interpret and use this information in search of the most technical-favourable solution; the solution that is also most favourable from a cost-performance point of view (Elgh & Cederfeldt, 2007). To do their work cost-consciously, engineers should therefore be conscious of the cause-and-effect relationships driving the costs of their design decisions, and they should receive proper feedback on their activities. According to Sandström and Toivanen (2002), they should also be conscious of the company's strategy because those who design new products must be familiar with their organisation's strategic focus. In this regard, the authors found the Balanced Scorecard (BSC) to be a helpful practice. Due to its ability to connect the company's strategy to operational levels by highlighting causal relationships, the BSC can be a helpful solution to clarify the strategic goals of the company to design engineers and find cause-and-effect relationships between engineers' design decisions and the performance of the company and, thus, support cost-conscious design by giving effective feedback to engineers on the progress of their activities.

In NPD projects intended for customers who consider the product's operating costs far more important than its purchase price, cost analyses must extend beyond manufacturing costs and embrace an Life Cycle Cost (LCC) approach (Durairaj et al. (2002) presents a review of existing LCC models). Accordingly, in the overall assessment of the new product design, cost estimations are expected to include the costs that the customers will bear during the operating life of the product. In these cases where the customer's perspective is important, Nixon (1998) concluded that the Total Cost of Ownership (TCO) is a critical *ex ante* calculation.

As the project progresses and reviews are conducted, and when the comparison of the cost estimates with the target cost demands a re-design of the product, the systematic Value Engineering (VE) technique can be used within the TC context (Nixon, 1998; Wouters & Morales, 2014). This allows the examination of cost drivers and supports the design efforts by finding ways to achieve the desired product at the target cost (Anderson & Sedatole, 1998; Rabino, 2001; Wouters & Morales, 2014; Wouters et al., 2016).

There are situations where the effectiveness of established cost-related MA practices might be compromised. When the nature of the NPD process moves away from the traditional sequential process, TC may be of limited use. Drawing on the evidence that many companies are currently adopting concurrent NPD instead of traditional sequential NPD, Gopalakrishnan et al. (2015) questions the effectiveness of setting specific cost goals in an uncertain, non-linear, and iterative concurrent NPD environment. The result of their experiment is that assigning specific cost goals to the design team in concurrent NPD

is no better than assigning them the general goal of controlling costs while designing the new product. Thus, higher task uncertainty in concurrent NPD than in sequential NPD is a limiting condition for TC. Other situations where TC might not be suitable are where the modelling of costs during the design stage is not simple and/or costs are not the major source of a competitive advantage (Davila & Wouters, 2004; Davila & Wouters, 2007). In these cases, alternatives to entrenched MA practices could be the establishment of parallel cost teams or the leveraging of the modularity concept (Davila & Wouters, 2004). These practices enable cost management not within but 'around' the NPD project, with the effect of not diverting the attention of design engineers away from product design. In these NPD projects, objectives rather than cost reductions, which in any case remain important, are critical factors for the project's success. Parallel cost management teams and modular design are therefore the preferred approaches identified by Davila and Wouters (2004) to exploit cost reduction opportunities during NPD, while retaining the focus of the development team on aspects that are determinants of project success. These approaches allow different organisational members, given their knowledge and expertise, to focus their attention on those tasks from which they can obtain the highest return. In parallel teams, cost experts work outside but also alongside the core project team and, in the process, update themselves on NPD activities' progress, make their cost management expertise available, and enhance cost consciousness within the development team. Their major challenge is to find cost-reduction opportunities and to maintain communication with the core development team. When it comes to modular design, the authors argue that, also in this case, modularity can be used in NPD to contain costs without drawing the attention of the core team away from other critical aspects. The non-core modules of the new product are developed outside the core project team. In this way, the project team do not need to concentrate on these modules, which in turn can receive adequate cost analyses separately.

4.1.2.2 Value creation measurement Costs only represent one element that determines the marketability of new products. Apart from cost modelling and cost management, Davila and Wouters (2007) highlight the importance of the value creation assessment of new product designs. Although criticised by many for its limitations in accounting for NPD uncertainty, and for its lack of flexibility and reaction to the additional information that becomes available during the progression of the project, the traditional Net Present Value (NPV) model is still the most commonly used value creation assessment practice in NPD projects (Davis, 2002; Varila & Sievänen, 2005). Alternatives, such as decision trees or real options which arguably best suit the multi-phased nature of NPD (also in light of their closer resemblance to stage-gate models), can be complex and time-consuming to implement, and are often not feasible during the early stages of NPD (Davis, 2002). Regardless, in response to those who debate the correct practices to determine the value creation potential of a new product, Varila and Sievänen (2005) claim that a profitability method cannot be judged as good or bad, appropriate, or inappropriate. The use of a particular method and the purpose of a specific analysis are the result of the information available at a specific time. Since information accumulates along the project's duration, the appropriateness of a specific method is dependent on the specific NPD phase (Nixon, 1998).

Hence, Revellino and Mouritsen (2015) claim that it is important to study the mutual building between MA practices and NPD over time. MA calculations do not work on innovation from the outside and without making distinctions. Instead, they work with innovation, in the process influencing innovation trajectories and being influenced by these trajectories. MA practices produce knowledge about the effects of innovation and ensures that knowledge supports the development of innovation by shaping and transforming its trajectory. According to this view, the calculative practice is much more than recording NPD. When NPD participants engage with MA practices, MA practices become an engine-driving innovation that brings a new product into existence. As the new product comes into existence, scenarios change and existing MA practices are transformed, thus enabling new MA practices to appear that, in turn, shape the trajectory of innovation and NPD. As such, innovation triggers a process of transformation and construction of new practices because, while innovation progresses, the object considered via MA calculations is being formed. Revellino and Mouritsen (2015), in accordance with Varila and Sievänen (2005), therefore conclude that a process of reciprocal adaptation – accompanying the evolution of the NPD process – exists between MA practices and NPD.

4.1.3 Non-financial management accounting practices

Non-financial MA practices, as an alternative to but also in combination with financial MA practices (Davila & Wouters, 2014), form part of the useful MA *'toolkit'* in NPD.

4.1.3.1 Non-financial management accounting practices to face uncertainty in new product development Carlsson-Wall and Kraus (2015) found that financial MA practices might be useless in the fuzzy front-end phase of NPD projects when a high degree of uncertainty determines the impossibility of performing financial quantifications (for instance, in their case, future revenues of the product under development could not be forecasted, thereby preventing the building of the business case). Instead, non-financial MA practices, such as stage-gate models (Cooper, 1990; Cooper et al., 2002), can be relevant (Carlsson-Wall & Kraus, 2015). They offer decision makers tools that can provide non-financial forms of quantification that might be fundamental to support the project's progress (Carlsson-Wall & Kraus, 2015).

Individuals use sense-making to interpret these practices and, based on the specific organisational context and the specific objectives pursued, to adapt them to the local context of use. As a result, the application of a stage-gate model can result in different forms (or variant modes, to use Taipaleenmäki's (2014) expression) of implementation when situated in the practical NPD context. For instance, in the case analysed by Carlsson-Wall and Kraus (2015) – an engine component manufacturer in the aerospace industry – this practice consisted of a staircase model employed to assess the development state of a new technology based on its maturity level. By structurally representing the technical progress of NPD, the staircase at hand also allowed the envisioning of possible future development states and the linking of these states to commercial potential, thus constructing arguments that could support the project's progress during its early stages.

4.1.3.2 Integrating financial and non-financial metrics to improve new product development performance Non-financial MA practices can also be useful in combination with financial MA practices when dealing with assessment problems beyond profitability. As of recent, MA has been increasingly called upon to help in the assessment of the environmental impacts of NPD projects in a variety of industries (e.g. Azzone & Noci, 1996; Ferreira et al., 2010). As a result, the traditional viability analysis of NPD projects must be merged, on an increasing scale, with environmental performance indicators (Azzone & Noci, 1996). In this case, the assessment of new products' environmental impact is crucial at the design stage, when design decisions affect the later production activities, the consequent number of undesirable outputs (Chan et al., 2014), and the future environmental performance of new products. In this case, Environmental Management Accounting (EMA) techniques (Burritt et al., 2002) are the key MA practices. By integrating non-financial and financial information, these practices can improve both the environmental and financial performance of NPD projects while also orienting the organisation towards sustainable businesses (Ferreira et al., 2010). In particular, the Life Cycle Assessment (LCA) – in combination with the LCC – has received increased attention as a fundamental tool in the EMA toolbox (Chan et al., 2014). As documented in the literature, cost reductions, improved product pricing, the attraction of human resources, reputation improvements, and a larger variety of decision-making information are amongst the main benefits associated with the use of EMA (Ferreira et al., 2010).

The challenge of measuring NPD activities and predicting the financial and non-financial consequences of (strategic) decisions made during the NPD process therefore finds support in MA practices. MA practices, which produce financial and non-financial information in disparate forms, constitute a toolbox that can support decision makers from different points of view during the NPD process.⁹

4.2 Management accounting information in new product development

The use of MA practices generates MA information (MAI). This second section focuses on the nature of this information and the role it may play in NPD.

4.2.1 The nature of management accounting information

Understanding the nature of MAI, namely its inherent character, is essential to gain an understanding of the roles that this information may play in an NPD environment. As will emerge, MAI's nature is heterogeneous and it materialises in different forms along different spectrums of variation, even within the same NPD context. In this paper, MAI is separated into financial and non-financial information, into formal and informal information, and is furthermore distinguished according to its degree of precision.

4.2.1.1 Financial and non-financial management accounting information Firstly, as showed in the previous section, MAI results from the implementation of both

⁹ Complementing this section, Appendix B lists all practices and financial measures mentioned in the examined papers that are commonly used in the NPD process.

financial and non-financial MA practices. MAI's nature therefore varies between the spectrums' opposite ends of non-financial and financial MAI (Davila, 2000; Carlsson-Wall & Kraus, 2015). Whereas the former includes non-financial measures (e.g. time, physical indicators describing the impact of the new product on the environment, etc.), the latter includes financial measures (examples are reported in Appendix B) (Azzone & Noci, 1996; Davila, 2000).

4.2.1.2 Formal and informal management accounting information Secondly, depending on the purpose and context of its use (Feeney & Pierce, 2016; Feeney & Pierce, 2018), MAI is used in NPD with a formal or informal connotation. These two extremes constitute a continuum reflecting the degree of formality involved in the preparation, format, and use of MAI. When MAI is assembled into a business case with the purpose of presenting and legitimising an NPD project and its implementation before a steering committee (in the context of a formal meeting), it is used with a formal connotation (Feeney & Pierce, 2016; Feeney & Pierce, 2018). Usually, from project to project within an organisation, this form of MAI is to a significant extent homogeneous. The information is prepared and formatted according to established procedures and standards, and it is used in formal situations. By contrast, in its informal forms, MAI is embodied in a language containing basic accounting concepts (e.g. cost, revenue, profit, loss, investment), which are used daily by NPD participants to discuss the project in progress (Feeney & Pierce, 2016; Feeney & Pierce, 2018). In this case, MAI is drawn upon casually, sometimes even subconsciously, when discussing aspects of the project and trying to figure out the potential (ballpark) financial implications of a certain course of action. For example, in Feeney and Pierce's case, the head of operations discusses the alternative cost implications of using a particular type of component instead of another type in the architecture of the product under analysis, with the head of finance. In this case, the informal use of MAI consists of dialogues that engage with accounting concepts and intuitive analyses, which "*might be performed at lunch on a copy of the newspaper*" (Feeney & Pierce, 2018: 263). During the early stages of NPD, the team members – often with the marginal support of the finance function – produce the informal MAI. As an interviewee claims, the marginal involvement of the finance function during the early stages of the project is a consequence of the fact that accountants find it difficult to prepare financial analyses of something that does not yet exist: "*you can't just say to your finance guys 'go and cost that' if the thing does not exist*" (Feeney & Pierce, 2018: 264). Thus, MAI also varies along the spectrum that reflects the progression of the NPD process. The nature of MAI changes as the project progresses and this reflects the change in the techniques and criteria used at various stages of the NPD process (Nixon, 1998).

4.2.1.3 Specific and relative management accounting information Thirdly, the nature of MAI is affected by the degree of precision of the information. Booker et al. (2007) analysed cost information in NPD by focusing on precision as a particular trait of information, and distinguish between specific cost information and relative cost information. As a result, the nature of MAI in NPD ranges from accounting figures

expressing the cost of a specific object in absolute terms to relative judgments (e.g. whether object X cost more/less than object Y)¹⁰

MAI may therefore have a '*chameleonic*' nature that lends itself to many different roles that this information may play during the different phases of NPD. As Nixon et al. (2011) note, MA is constantly present at each stage of the NPD process. Its use and its nature in NPD projects vary between companies and project managers. Organisational rules and routines, the preferences of individual project managers, and the criteria used (financial or non-financial) to assess business opportunities are seen as the main causes of these differences (Tervalo et al., 2017). Thus, MAI reflects different rules and routines of different organisations, different preferences of individual project managers, and changes in the techniques and criteria used during various stages of the NPD process.

4.2.2 The roles of management accounting information

Reporting on the roles of MAI means outlining the key functions and advantages that the information may serve or bring about in an NPD environment. These functions and advantages, as will become clear and as implied by the conceptual framework (Sect. 3), are connected to both the more technical-oriented aspects and the more sociological-oriented aspects of the MA phenomenon in NPD.

4.2.2.1 The more technical-oriented roles: performance assessment, learning, coordination, decision making, and negotiation Starting with MAI's more technical-oriented roles in NPD, its relevance starts at the earliest phases of the NPD process (Anderson & Sedatole, 1998; Nixon et al., 2011). Price, sales volumes and costs, including operating costs for future product owners, are fundamental data to build the business case and to conduct the viability analysis during the earliest stages of strategy definition and concept development (Nixon et al., 2011). Financial targets set in this phase – for instance, return on sales and investment, design and development costs, manufacturing and assembly costs, and the total cost of ownership – serve as a basis to manage the intended NPD process while making fundamental go/no-go stage-gate decisions (Jørgensen & Messner, 2010). The financial attractiveness of an NPD project is assessed before the actual development starts; at a later stage, financial performance is expected to follow from non-financial performance (Davila, 2000), for instance, by complying with the project's time schedule.

Because of its ability to facilitate the fit between a new product's design specifications and the financial needs of the project during the concept development stage of NPD, Anderson and Sedatole (1998) claim that MAI is useful in designing higher quality products. In this regard, the role of MAI in influencing NPD designers might depend on its specific or relative nature. The experimental study conducted by Booker et al. (2007), which focused on cost information, shows that designers who are provided with specific cost information tend to generate more cost-effective designs and that this increased cost-effectiveness does not come at the expense of product features.

¹⁰ See footnote 18 for an example of relative MAI production and use in NPD.

MAI can result from a single MA calculation or from a combination of multiple MA calculations. Mouritsen et al. (2009) refer to the former as '*short translation*' and to the latter as '*long translation*'. In the case of '*short translation*', a technological innovation is translated in terms of, for instance, high sales performance or low direct costs. This information points to the courses of action to reach target sales performance or target direct costs. In the case of '*long translation*', the translation captures the innovative phenomenon from differently generated viewpoints (e.g. the perspective of high sales performance might suggest increasing the number of the product's components, aiming for higher customisation, while the perspective of low direct costs might suggest the opposite). In this case, it is likely that the courses of action suggested by different sets of MAI contrast with one another. This causes tension that, in turn, shapes the development path by not only implementing the initial NPD strategy but also by extending it to meet competing objectives (Mouritsen et al., 2009). According to Mouritsen et al. (2009), it follows that the most significant role of MAI, especially of combined multiple information, is to inform managers about the details of their affairs and, by doing so, to enable them to act consequentially and consciously. Janssen et al. (2011) refers to this way of using MAI as its conceptual use. According to their findings, which confirm those of Mouritsen et al. (2009), a balanced set of information – qualitative and quantitative that covers financial and non-financial aspects – increases the extent to which MAI can be used conceptually, more specifically for learning purposes and knowledge development in NPD. Also Lassila et al. (2019) report a case of the use of MAI for learning purposes and knowledge development in NPD. They conducted a case study in a fully digital NPD environment – the free-to-play mobile gaming industry. In this case, MA calculations are identified with game analytics and MAI is identified in the real-time feedback of users (captured with game analytics practices) who experienced the last available release of the game under development. The authors explain how this information forms the basis for knowledge accumulation (on what works to what does not work), discussion, decision making, and further action to develop what is called a '*good game*'. The latter refers to an ideal numerical representation of the product under development, resulting from the combination of several MAI combinations that, every time a design choice is made, point to possibilities of improvement and perfection.

When it comes to inter-organisational relationships, MAI information can play a '*technical*' role in the coordination of a firm's inter-organisational field, concerning both non-temporary and temporary organisations. In the case of non-temporary organisations, that is, established firms working on an NPD project, MAI can support the coordination of the project by easing decision making, amongst others, extending existing configurations of actors involved in NPD (e.g. existing suppliers) or assisting the evaluation of alternative possibilities (Mouritsen et al., 2009). In the case of temporary organisations, that is, organisations made up of several participants representing non-temporary organisations who gather with the aim of co-developing a new product and who only remain together for the time necessary to achieve the development goal, MAI can play a key role in setting the project's financial boundaries (its developmental budget and the target cost for the product to be developed), thus supporting its governance. In these cases, financial numbers remain important during the project, in the sense that they are monitored. However, the assessment of product development at the '*gates*' usually focuses on technical information. Because of the

temporary nature of the organisation, the primary focus of this project type is on the technical development of the product within the financial budget set out in the business case (Meer-Kooistra & Scapens 2015).

When input data, required to set MA calculations of a financial nature in motion, is not available, only MAI of a non-financial nature plays a key role in supporting NPD. The Carlsson-Wall and Kraus (2015) case study serves as an example. According to their findings, MAI – resulting from the implementation of a maturity staircase indicating the level of technological maturity of the innovation (Sect. 4.1.3) – constituted the means by which the R&D department could document and justify its work. In doing so, it represented an internal mediating instrument between top management and the R&D department. The former was interested in the commercial potential of the innovation, while the latter was concerned with its technical development. Information on the level of maturity of the innovation provided a basis for discussion between the two parties and, at the same time, constituted data that fostered communication and negotiation with external actors relevant to the success and prosecution of the project (i.e. funding agencies).

4.2.2.2 The more sociological-oriented roles: management accounting information as a connector and mediator Moving on to the more sociological-oriented roles, MAI can constitute an object of conversation for project participants that, in different situations and with different forms, can support collaboration and coordination and direct the project towards those targets that satisfy the company and its stakeholders, as well as its customers (Nixon, 1998). Nixon writes in his paper that in the case organisation he analysed, “*costs became the single vernacular that integrated the interests and activities of project participants and the customers*” (1998: 340). Jørgensen and Messner (2010) found that between the gates, when not in front of the members of the steering committee to whom formal MAI is presented, MAI can be used in a qualitative (or informal (Feeney & Pierce, 2018)) way. In this case, MAI is used in dialogues between NPD participants and as a general understanding of the need to be profitable, to pass to the next gate, or to discuss courses of action. Thus, from this perspective, MAI has the power to connect and mediate between different actors and, in its role as mediator, it facilitates communication between NPD participants belonging to different domains of practice (e.g. Sandström & Toivanen, 2002; Laine et al., 2013; Laine et al., 2016; Leotta et al., 2020). This is a key role of MAI, to the extent that Christner and Strömsten concur that “*accounting calculations are not interesting primarily because of their technical properties, but because of the connections they make*” (2015: 64). In this regard, according to Laine et al. (2016) and Rantamaa et al. (2014), the co-development and use of MA practices by different actor groups can benefit a comprehensive and general understanding of the NPD project’s business impact. Moving from the idea of accounting prototypes (Wouters & Roijmans, 2011) – namely accounting tools jointly and iteratively developed by different actor groups belonging to different business functions – Laine et al. (2016) and Rantamaa et al. (2014) conclude that these tools and the information they produce can facilitate communication, knowledge integration, and learning between NPD participants belonging to the different fields of MA and engineering. MA prototypes provide an opportunity to integrate different business functions’ viewpoints into MA practice, thus generating a comprehensive view of

the NPD project and activating new discussions among the NPD participants. Their findings show the importance of being able to deal with organisational boundaries in the development and use of MA practices, especially in the NPD setting where several boundaries exist between actors responsible for different business functions and between different levels of the organisation. In this sense, the case study conducted by Sandström and Toivanen (2002) is exemplary. The information provided by the BSC, used to align NPD engineers with the strategic orientation of the company and the need to operate in a cost-conscious way (Sect. 4.1.2), not only acts as a mediator between different actors and domains but also arouses feeling among NPD engineers of actually being connected to the organisation.

4.3 Management accountants' involvement and roles in new product development

This section focuses on how MA is engaged in NPD projects. This implies analysing the human side of an MA presence in NPD, that is, management accountants. MA *per se* is a discipline that would remain theoretical if not put into practice by skilled professionals. Hence, the aim of this third section of the literature review is to systematically report the roles that management accountants can play in NPD settings.

4.3.1 Management accountants' involvement in new product development

Management accountants are key strategic partners who understand the financial and operational sides of a project or an entire business and who are future oriented to create value for organisational stakeholders (Garrison et al., 2012). Nevertheless, there is still mixed evidence of management accountants' involvement in NPD projects. Existing studies range from the almost complete absence of management accountants in the NPD project team (Rabino, 2001; Varila & Sievänen, 2005; Jørgensen & Messner, 2010; Taipaleenmäki, 2014; Meer-Kooistra & Scapens 2015), to them occupying ancillary roles (Hughes & Pierce, 2006), and to them displaying high-level involvement in NPD activities (Nixon et al., 2011; Akroyd et al., 2016) from the outset of the project (Hertenstein & Platt, 1998; Nixon et al., 2011).¹¹

When the management accountant is absent, it can be the result of the long-existing cultural separation of engineers and accountants which also serves as the source of management accountants' exclusion from new product design decisions. Anderson and Sedatole (1998) refer to cases like these by describing engineers as NPD actors

¹¹ Although it cannot be confirmed with any certainty, this different degree of engagement of management accountants in NPD projects might also derive from the contrasting positions that exist in the MA literature on the person of the management accountant. The MA literature, in fact, often disputes the role of accountants, labelling them as *bean counters* or *scorekeepers* at times (e.g. Burns & Vaivio 2001; Zoni & Merchant, 2007) or as *strategic business partners* at other times (e.g. Burns & Baldvinsdottir, 2005). As will become evident from the literature review and as Feeney and Pierce (2016, 2018) conclude, effective management accountants in NPD are those who are able to include the skills of both a bean counter and a strategic partner in their professional profile.

who subscribe to the stereotype that the accountant is someone who compromises design decisions to save cents.

When management accountants are present but their role in NPD is ancillary, it can be that the relationship between the accountant and the product design team is tense. Hughes and Pierce (2006) ascribe this to three reasons. Firstly, it can be an organisational problem, that is, a problem of insufficient interface between product designers and management accountants in daily NPD activities that prevents effective collaboration. Secondly, it can be a problem about the perception of a creative gap. In this event, engineers believe that management accountants are unable to understand the concept of innovative learning¹² and therefore lack the long-term perspective that is necessary in NPD. Thirdly, it can be that the financial knowledge of NPD engineers is such that they believe they do not need management accountants. In this case, engineers question the need for accountants in the project because, according to them, they only deliver a limited input to NPD. As a result, the literature reports that several firms rely on cost engineers instead of management accountants as a link between MA and NPD (Nixon, 1998; Meer-Kooistra & Scapens 2015), overlooking the extensive set of benefits and competitive advantages that management accountants could provide in an NPD setting (Rabino, 2001). Drawing on Rochford (1991)'s eight-stage model of the NPD process,¹³ Hughes and Pierce (2006)'s findings suggest that management accountants can contribute to all NPD stages. The roles and activities that management accountants are able to play and perform in NPD are examined in the next subsections.

4.3.2 The double-hatted strategic-operational role

Akroyd et al. (2016) signal the importance of involving management accountants in both corporate strategy formulation and NPD. In this way, because of their participation in two teams at different organisational levels (i.e. one strategic and the other operational), management accountants play a dual role that gives them the ability to influence both strategy formulation and strategy implementation. In the case analysed by Akroyd et al. (2016), the management accountant was not only involved with senior management in the task of formulating strategy, but also with the NPD team in the task of strategy implementation through product development activities. As a result, the management accountant was able to facilitate product development activities by bringing ideas discussed in senior management meetings to the NPD team. This not only ensured strategic alignment, but also facilitated and eased information flow between top management and NPD participants.

In their position, management accountants can also facilitate the flow of information in the reverse direction, that is, from the operational level to the management level. Management accountants provide relevant information to top management

¹² Spending time and money to design a product that does not make it to production is not entirely a waste of time. It might become useful at a later stage to facilitate the development of future products (Hughes & Pierce, 2006).

¹³ According to Rochford (1991), the NPD process includes the following eight stages: strategic planning, opportunity identification, business analysis, feasibility study, development, testing, introduction, and commercialisation.

based on the work done at the operational level and, as such, impact strategy formulation. In this regard, Hertenstein and Platt (1998) found that because of the outlined dual role that management accountants can play in NPD settings, they facilitate communication between the project team and senior management about the status of the work done and the financial resources needed to undertake forthcoming NPD activities. Nixon et al. (2011) present another case where the management accountant held the same position with the intention of keeping a balance between commercial, engineering, and financial criteria. Positioned between the CEO and the financial director, the management accountant had the dual responsibility of bridging strategic goals with operational targets. In practice, it meant that the management accountant was involved in a continuous and iterative top-down/bottom-up interaction process aimed at facilitating the balance between the design of the product and its technical performance with the financial requirements of both the company (i.e. profit) and its customers (i.e. purchase price and ownership cost).

There is another way that management accountants could play a role in strategy formulation. By using their understanding of financial statements and their analytical skills, management accountants can analyse a firm's historical financial performance and, by doing so, contribute to the process of strategic planning in two ways (Hughes & Pierce, 2006). Firstly, by recognising the need to innovate when financial indicators signal such a need. Secondly, by exploiting the same skills and conducting the same activity on competitors' financial statements. Therefore, management accountants could play a role in extracting useful information from competitors, thus finding NPD opportunities or alerting the management team about potential or new entrants in the company's current markets (Hughes & Pierce, 2006).

4.3.3 Strategic partners for design engineers

The review evidence suggests that management accountants could serve the role of strategic partners to NPD engineers in several ways. During the early phases of NPD when the product's design is still flexible, opportunities may exist for changes that guarantee the balance between the product's attributes and its financial performance. Therefore, Hertenstein and Platt (1998) emphasise the importance of management accountants' inclusion in the NPD team from the outset of the project. The early presence of management accountants in the engineering decision-making process can, actually, help NPD designers by providing financial impact evaluations of their design decisions (Nixon, 1998) and by forecasting potential profits and losses related to the new venture (Hughes & Pierce, 2006). Because of their expertise, the project team can benefit from the application of the most recent MA techniques and, thereby, be placed in a position where it can take more informed decisions while avoiding time wasting caused by paths that lead to unprofitable outcomes (Rabino, 2001). Regarding profitable paths, and to sustain future NPD activities, management accountants can support the activity of external fundraising and investment decisions on the use of new technologies in the manufacturing process, thus identifying the best solutions for the company from a financial viewpoint (Hughes & Pierce, 2006).

Anderson and Sedatole (1998) suggest that a rewarding way of engaging management accountants in NPD activities is to team them up with engineers. In this

way, they can develop integrated and advanced MA systems, especially cost estimation systems capable of incorporating firm-specific data, thus going beyond standard industry cost tables and standard cost estimation methods. When the voice of the customer becomes important in the development process – as in the case of products whose operating costs are more significant than the initial purchase price – management accountants' role is to balance the customers' operating expense needs and the manufacturer's profitability target (Nixon, 1998; Nixon et al., 2011). The role of management accountants is to evaluate the relative importance of different operating cost categories for the customer and then to provide this information to the engineering team, who can analyse it in terms of product design implications (Nixon, 1998). Hence, the management accountant acts as a mediator (making use of formal and informal MAI, and of MA language) between different actors and different needs (Feeney & Pierce, 2016; Feeney & Pierce, 2018). As previously discussed, "*management accounting is very much the single, most-used language to co-ordinate the activities of all NPD project participants*". It is a "*vital part of the communication needed to negotiate, link, and balance all the perspectives*" (Nixon et al., 2011: 7). Therefore, the presence of management accountants in NPD can foster and guarantee the proper use of this language. As Feeney and Pierce (2016, 2018) claim, in the performance of their tasks, management accountants can transfer their basic knowledge to NPD participants so that they can autonomously use MAI (and its language) daily in their communicative practice. At the same time, management accountants' presence is also a strength when it is necessary to elaborate MAI. The conceptual use of MAI requires experts (Janssen et al., 2011). Companies that rely on engineers to do some of the management accountant's work risk the possibility of not being able to collate the information in a comprehensive and long-term-oriented financial plan for the organisation (Hughes & Pierce, 2006).

When taking decisions on outsourcing, management accountants can be valuable partners of design engineers. In the contemporary global market, customers' requirements have increased products' complexity and shortened their life cycles. This has increased competition while confronting companies with the need to deliver more products at a faster rate. In this context, to meet the ever-increasing complexity of new products demanded in short time frames, NPD teams have begun to face the lack of internal capabilities. Hence, they have started to rely on external expertise, thereby outsourcing specific NPD activities. According to Barragan et al. (2003), effectively sourcing elements of NPD requires '*assembling the expertise*' involving engineers, business experts, and supply chain experts in the decision-making task. When it comes to supplier selection and partnering relationship management, engineers are in charge of communicating their technical needs to external companies, and they have the capability to assess the quality of the technical outcomes delivered by these companies. However, their knowledge is insufficient to effectively manage the relationship with external partners if it is not integrated with the more business-oriented knowledge of management accountants, who can provide their expertise to support engineers in outsourcing NPD decisions.

In conclusion, management accountants are key team members in NPD projects. Their early inclusion in the NPD team is fundamental for the success of any project (Anderson & Sedatole, 1998; Hertenstein & Platt, 1998; Carlsson-Wall & Kraus, 2015; Akroyd et

al., 2016), but it is only effective and useful if management accountants participate in the NPD activities in a flexible and proactive way (Hertenstein & Platt, 1998). As a result, management accountants must adopt a flexible approach to financial analyses, which means that they must embrace estimates in lieu of precise calculations and conduct ‘*what if*’ analyses to truly understand the financial side of the new product design (Hertenstein & Platt, 1998). They must be able to go beyond traditional financial indicators by integrating a variety of financial and non-financial information (Hertenstein & Platt, 1998; Davila, 2000; Hughes & Pierce, 2006). It may be extremely difficult to perform financial quantifications, especially during the fuzzy front-end phase of NPD. Management accountants’ behaviour that previously focused on traditional financial quantifications should hence make room for more flexible and dynamic behaviour that uses any means that are likely to foster the innovation process (Carlsson-Wall & Kraus, 2015). In conducting their analyses, they must adopt a broad perspective that extends beyond a single supply chain actor. In doing so, they must develop a collaborative and service-oriented attitude along with interpersonal skills that, when necessary, allow them to deal with the occurrence of any controversy or resistance (Hertenstein & Platt, 1998). They must be an integral and constant part of the team (Hertenstein & Platt, 1998; Anderson & Sedatole, 1998) and, when necessary, they should be willing to embrace technical training in addition to existing financial training (Hughes & Pierce, 2006). This would boost and ease their interface with NPD engineers.

Finally, a recent study by Lee and Wang (2020) found that a proper fit between management accountants’ activities and the firm’s core strategy improves NPD performance.¹⁴ Accordingly, management accountants in companies using the cost leadership strategy should focus on cost control and profit management activities, while those operating in companies using the differentiation strategy should emphasise cost planning activities.¹⁵ In line with the previous discussion (Sect. 4.3.2), the strategic orientation of a firm should provide accountants with information on how to operate in support of NPD at an operational level.

4.4 Directions for future research

This paper recognised the threefold identity of MA research in NPD along a spectrum that ranges from the more technical-oriented aspects of MA to the more sociological-oriented aspects. This section encourages future research in three ways.

Firstly, as a result of this papers’ attempted knowledge consolidation, nine research propositions are developed based on the existing literature. Because they derive from the attempt to consolidate fragmented research – undertaken in different contexts, at different times, and with different research methods and perspectives – more empirical research in future is needed to test these propositions. Secondly, to complement the research propositions, a systematisation of the calls for future research existing in the literature is proposed.

¹⁴ In this paper a distinction is made between a cost leadership strategy and a differentiation strategy, and the metric used to measure NPD performance is the sales of new products over total sales.

¹⁵ According to Lee and Wang (2020), cost planning activities include: computing the cost of capital to develop new products, estimating the LCC, setting and decomposing cost targets, preparing budgets, participating in the design and maintenance of cost tables, and analysing product costs’ variations as product design varies.

The objective is to provide a systematic research agenda that can guide future investigations with the aim of stimulating the development of a field that, despite its relevance to the world of management (Davila et al., 2009), is currently insufficiently understood and theoretically underdeveloped (Davila et al., 2009; Laine et al., 2013; Carlsson-Wall & Kraus, 2015; Christner & Strömsten, 2015; Moll, 2015; Feeney & Pierce, 2016; Feeney & Pierce, 2018; Major et al., 2018). As it will emerge, the propositions and suggestions for future research found in the literature are, for the most, consistent. Thirdly, general calls and suggestions for future research are provided.

4.4.1 Research propositions and related research calls

The propositions and the related calls for future research are organised according to the research framework adopted in this paper.

4.4.1.1 Management accounting techniques and calculations Based on the analysis of the more technical-oriented research contributions of MA in NPD, we formulate the following propositions:

Proposition 1

MA practices largely vary in NPD contexts. The variations involve the MA practices' development stage, sophistication level, and type of information that they produce.

Proposition 2

MA practices and NPD activities reciprocally adapt to each other as the NPD process progresses. Therefore, a process of mutual adaptation exists between NPD activities and MA practices. + T

Proposition 3

MA practices play a supportive role during the early phases of NPD by enabling forms of reasoning such as accounting thinking.

According to earlier studies and consistent with the outlined set of propositions, advancing knowledge of MA practices in NPD requires the study of NPD processes in diverse settings and over time (Christner & Strömsten, 2015). Concerning the first aspect – the space dimension – the literature points to different opinions on ways to proceed with future studies. According to some authors, simply describing inspiring examples of original and innovative MA practices – individually and in combination with one another – suffices as a valuable contribution to the literature. These practices may not work everywhere, but they nevertheless serve as a valuable piece of knowledge and a source of inspiration to researchers and practitioners (Taipaleenmäki, 2014; Wouters & Morales, 2014; Wouters et al., 2016). According to other authors, most studies – to date – lack a theoretical foundation or mainly adopt a functionalist perspective (Davila et al., 2009; Moll, 2015; Feeney & Pierce, 2016; Feeney & Pierce, 2018). Therefore, apart from noting that although certain MA techniques are relied upon in NPD, they do not explain why these practices match the particular NPD setting in which they are employed or the roles these practices play in the NPD process (Moll, 2015). Consequently, to better understand “*how accounting is actually practised in the (specific) context of new product development*” (Jørgensen &

Messner, 2010: 186), there is a need to discontinue the study of MA practices ‘*from a distance*’ (there are exceptions, e.g., Nixon, 1998; Laine et al., 2016; Feeney & Pierce, 2018). Instead, to this end, alternative theoretical perspectives and approaches might be worthy of attention (Davila et al., 2009; Laine et al., 2013; Moll, 2015; Feeney & Pierce, 2016; Feeney & Pierce, 2018). Concerning the second aspect – the time dimension – advancing existing knowledge of MA in NPD requires paying attention to the mutual constitution of MA practices and NPD over time (Revellino & Mouritsen, 2015). This also requires differentiating between the phases of the NPD process (Davila et al., 2009) and emphasising the importance of the first fuzzy front-end phase of NPD that, at present, is fraught with a “*worrying*” lack of understanding on the part of researchers and practitioners (Carlsson-Wall & Kraus, 2015: 185).

4.4.1.2 Management accounting information types and roles Moving from more technical-oriented research towards the opposite end of the MA in NPD research spectrum, its mid-section contains research contributions that focus on the outcomes of MA practices, namely MAI. Based on the overall review of research contributions on the types and roles of MAI in NPD, we formulate the following propositions:

Proposition 4

MAI supports NPD activities with different data types. It can be financial or non-financial data, it can be prepared, formatted, and used with varying degrees of formality, ranging from standard and formal data to non-standard and informal data, and it can be exact or relative data.

Proposition 5

MAI allows NPD actors to better understand the NPD phenomenon with which they are dealing. MAI forms the basis of performance management, knowledge development and learning, coordination, process management, decision making, and negotiation. T / S

Proposition 6

By acting both as a connector and a mediator, MAI forms a language that fosters communication among project participants, thereby enabling collaborative activities and their coordination at a cross-functional level.

The calls for future research retrieved from the literature support the use of future explorations to test these propositions. According to earlier investigations, when investigating MA practices and their operational use, there is also a need to examine how these practices relate to and intersect with other activities and practices (i.e. the co-development and/or co-use of MA practices by actors with various backgrounds). “*An increased examination of such intersections would not only be worthwhile for accounting researchers but is also likely to increase the interest of other discipline in the outputs of accounting research*” (Jørgensen & Messner, 2010: 203). In this regard, there is a need to investigate the conditions under which certain MA calculations connect and mediate between different actors and domains (Christner & Strömsten, 2015), and how these connections and mediations function. Therefore, more research is needed to understand how MA connects different actors and domains while mediating between them (Christner & Strömsten, 2015; Laine et al., 2013; Laine et al., 2016; Feeney & Pierce, 2018; Mämmelä et al., 2019) in NPD activities. Feeney and Pierce (2018) stress the importance of empirically exploring the interac-

tions between NPD participants and how MAI engages in these interactions. Therefore, when investigating these links, attention must be paid to understanding the communication mechanisms that underpin the interactions between the various NPD participants (Mämmelä et al., 2019). In this regard, it would be worthwhile to conduct research on the use of MA as a mere discussion tool in NPD, which makes use of accounting concepts and accounting thinking without involving MA calculations (Taipaleenmäki, 2014). Alternative perspectives and approaches deserve attention in this case as well, because they could be effective to capture the use of MA in practice, in the process going beyond its technical properties (Christner & Strömsten, 2015) by examining the social phenomenon in which MA engages in NPD and the underlying reasons and resulting implications of MA practices' shape and use in diverse settings and at different stages of NPD projects.¹⁶

4.4.1.3 Management accountants' involvement and roles The final propositions, being of a more sociological-oriented nature because they centre on the person of the management accountant, could stimulate future research on management accountants' presence, attitude, and roles in NPD activities. The following propositions are formulated:

Proposition 7

It is critical to involve management accountants in NPD activities as early as possible. In this way, management accountants can assist NPD engineers with their design decisions' impact evaluations and, accordingly, direct the engineers' decision-making process towards financially sound solutions.

Proposition 8

Management accountants should participate in the NPD activities in a flexible and proactive way so as to truly comprehend the financial side of a new product concept and foster the innovation process through both conventional and unconventional practices. + S

Proposition 9

Management accountants involved in NPD activities play a role in both the creation and the execution of an organisation's strategy.

In this case, the calls for future research found in previous studies are less specific and more general but nevertheless aligned with the formulated propositions. According to the literature, future studies should pay attention to investigating and better delineating the roles played and contributions made, respectively, by management accountants during each stage of the NPD process (Hughes & Pierce, 2006).

¹⁶ For instance, Magnacca (2021) and Magnacca & Giannetti (2022) present a case study on the fuzzy front-end phase of NPD where the high uncertainty pervading the NPD environment prevents the immediate use of established MA practices and the production of precise MAI. In this case study's setting, the application and use of MA required coordination with the NPD engineering team. Management accountants and engineers collaborated on the development of context-specific MA practices. The outcome of these practices was relative MAI, that is, information on the performance of a new product concept relative to the performance of its competitor product. This type of information, instead of precise calculations, was used to discuss the project within the cross-functional development team, to evaluate alternative courses of action, and to justify its implementation beyond the front-end stage to external stakeholders (funding agencies and companies interested in the commercial potential of the investigated product).

4.4.2 General calls from the literature and further research suggestions

In this section, first, some general calls for future research are provided. These are calls for future research based on previous studies that assume a more general connotation in respect to the calls related to the research propositions above. Then, we advance suggestions for future research. These are not based on previous research, but we believe they are worthy of consideration besides the rich outlined research agenda. They are related to currently relevant social and technological phenomena, and they propose an alternative perspective of investigation to that adopted so far for the exploration of MA in NPD. Our set of suggestions can also be used as a foundation for future empirical research to evaluate the proposed propositions.

4.4.2.1 General calls from the literature The NPD field develops continuously. Future studies should explore the role of MA in inter-organisational contexts (Christner & Strömsten, 2015; Meer-Kooistra & Scapens 2015) and collaborative R&D projects. Particularly, additional research should investigate MA in (project-based) temporary organisations, especially “*given the rise of such organisational arrangements in NPD in key sectors of the economy*” (Moll, 2015: 9). The use of MA in NPD activities at a distance and among the companies of different countries is another emerging theme that is worthy of attention (Moll, 2015). Another interesting theme for future research is the interaction between external factors directed at stimulating NPD, such as European Union research funds, and the MA practices that companies use to adapt to these external factors (Davila et al., 2009). To engage with the outlined research agenda, it is suggested that, as promising research designs, more in-depth and case-based studies be used in combination with longitudinal ethnographies (Davila et al., 2009; Carlsson-Wall & Kraus, 2015).

4.4.2.2 Further research suggestions Firstly, future studies could explore the effectiveness of an MA presence in NPD. It would be rewarding to explore the impact of MA in terms of benefits gained before and after its introduction to NPD projects. Secondly, on-going mega-trends in society, especially digitalization, sustainability, and servitization fundamentally change the conditions for manufacturers when they develop new products. Therefore, it would be of interest to explore the impact of these trends on MA practices and calculations in NPD. Thirdly, and this is aligned with calls and research suggestions for alternative investigative lenses and approaches to explore the MA phenomenon in NPD, future research could be undertaken by adopting an effectuation perspective to the analysis of MA in NPD (Sarasvathy, 2001). NPD revolves around a set of decisions to be made, and MA provides solid support to decision makers. Regarding the latter suggestion, NPD – in contrast to decisions where causation processes are effective for decision making, that is, decisions for which both the central artefacts and the business context within which the decisions are made, exist – can or often involves decisions for which the product and/or the market, but sometimes even the firm, do not yet exist. As an example, we can think of a project of radical innovation, undertaken by a group of people who eventually may form a start-up if a market exists for the innovative product. In these situations, typical of NPD during its early phases, acting involves decision making in the absence of pre-existent and well-defined goals, but looking at the future and facing dynamic and

uncertain environments with all available means to reach the desired effect. It would therefore be of interest to see whether an effectuation perspective to explore MA in NPD provides any advantage to our understanding of the phenomenon. As Sarasvathy conjectures, “*in financial decisions, in contrast to traditional decision makers, effectuators are less likely to use long-term planning or net present value analyses; instead, they are likely to be focused on the short term and, at most, to use informal versions of real options*” (2001: 261). Even if research – to date – adopted the causation perspective, a change in perspective could lead to interesting discoveries.

5 Conclusions

The aim of this paper was to systematically review studies on MA in NPD and to provide a theoretically coherent narrative of the subject of interest as a means to overcome the fragmentation characterising MA research in NPD. This narrative was created by relying on a conceptual framework that reflects the intrinsic nature of any MA phenomenon, also in the context of NPD. The proposed conceptual framework, by recognising the threefold identity of MA research in NPD, reveals three lines of research along which all previous investigations are located and, therefore, constitutes a ‘*lighthouse*’ for researchers and practitioners who, in future, aim to contribute to the existing debate and knowledge creation at the intersection of MA and NPD. The first line of research points to the importance of focusing on management accounting techniques and calculations, of both a financial and non-financial nature, at various levels of sophistication. In this regard, a lot is already known, such as the role of cost management techniques and calculations through NPV, but a lot can still be studied concerning MA practices design and implementation in NPD contexts, for instance, inter-organisational NPD. Such studies should propose the development of techniques and calculations, incorporating the key elements of the NPD context, which, at present, need further investigation. The second line of research confirms the role of MA in an NPD project, both as a connector of and a mediator between different participants who belong to different domains of practice. Again, much can be done in terms of research, especially dedicated to exploring the social conditions that enable MA at the intersection of different disciplines engaged in NPD activities. Finally, the third line of research establishes the strategic partner role of management accountants in NPD projects and calls for investigations that create space for various in-depth analyses into the role and competences of management accountants at various stages of the development process. These lines of research, because they have a mutually reinforcing and explicative value and are essential, constitutive aspects of the MA phenomenon in NPD contexts, are of equal importance in the progress of scientific enquiry. In this regard, our outlined research propositions and research agenda point to several, potentially rewarding research opportunities.

The fragmentation of MA research in NPD is what motivated us to draft this article. We hope that, when looking at previous research through the lens of this threefold perspective, the knowledge on MA in NPD would not appear as fragmented as before.

6 Appendix A

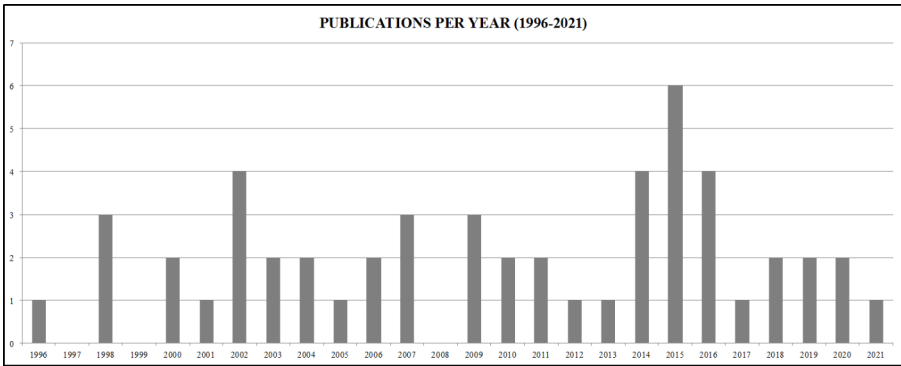


Figure A.1 Number of manuscripts in each year

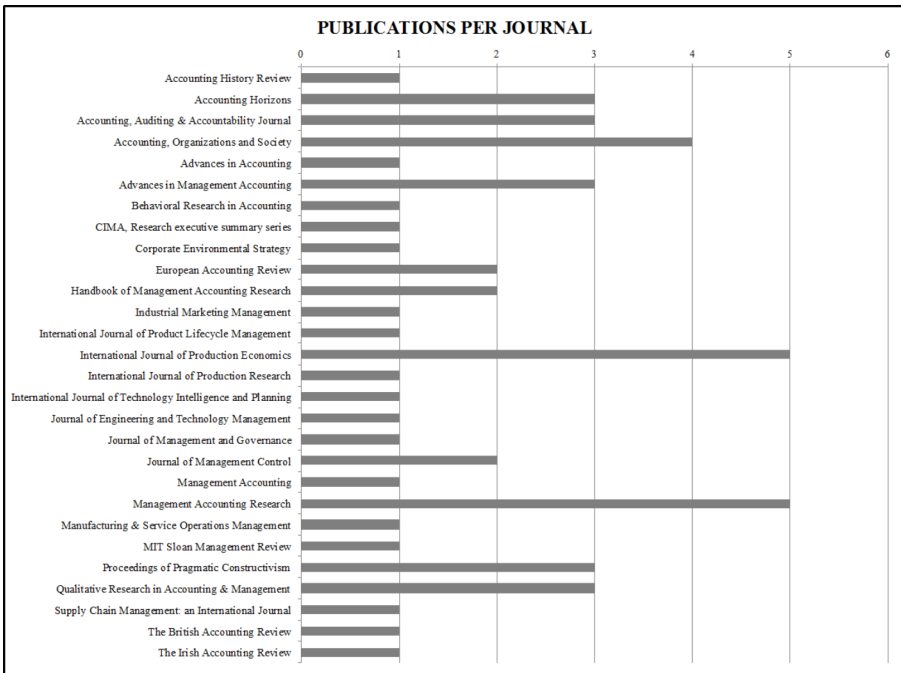


Figure A.2 List of journals and number of manuscripts in each journal (1996–2021)

7 Appendix B

Financial management accounting practices		Non-financial management accounting practices
Cost management and estimation	Value creation measurement	
<p>Target Costing (e.g. Ansari et al., 2006; Burrows & Chenhall, 2012)</p> <p>Cost estimation practices (e.g. Tornberg et al., 2002; Elgh & Cederfeldt, 2007)</p> <p>Balanced Scorecard (e.g. Sandström & Toivanen, 2002)</p> <p>Life Cycle Costing (e.g. Durairaj et al., 2002; Mueller, 2009; Chan et al., 2014)</p> <p>Total Cost of Ownership (e.g. Nixon, 1998)</p> <p>Value Engineering (e.g. Nixon, 1998; Wouters & Morales, 2014)</p> <p>Design-to-cost techniques (e.g. design for manufacturing, design for assembly) (e.g., Wouters & Morales, 2014; Wouters et al., 2016)</p>	<p>Net Present Value (e.g. Varila & Sievänen, 2005)</p> <p>Advanced forms of Net Present Value (e.g. with probability or sensitivity analyses) (e.g. Davis, 2002; Varila & Sievänen, 2005)</p> <p>Internal Rate of Return (e.g. Christner & Strömsten, 2015)</p> <p>Pay-back time (e.g. Leotta et al., 2020)</p> <p>Real options (e.g. Varila & Sievänen, 2005)</p>	<p>Stage-gate models (e.g. Carlsson-Wall & Kraus, 2015)</p> <p>Life Cycle Assessment (e.g. Ferreira et al., 2010; Chan et al., 2014)</p> <p>Scenario analysis (e.g. best <i>versus</i> worst case scenario) (e.g. Tervala et al., 2017)</p>

Table B.1 Management accounting practices (individually, or in combination, e.g. Net Present Value+ Scenario analysis)

New product price
Expected revenues from the sale of the new product
New product cost
Contribution margin
Profit margin after R&D indirect costs (i.e. contribution margin – R&D indirect costs)
Profitability information

Table B.2 Financial measures commonly used in the NPD process

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