Review of Managerial Science (2022) 16:135–156
https://doi.org/10.1007/s11846-021-00441-4

ORIGINAL PAPER

Digital innovation management for entrepreneurial ecosystems: services and functionalities as drivers of innovation management software adoption

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Received: 26 March 2020 / Accepted: 4 January 2021 / Published online: 27 January 2021

Abstract

Innovation Management Software can promote Entrepreneurial Ecosystems by consolidating an organization's innovation programs, stakeholders, and resources in one place. In this study, we highlighted the digitalization of innovation processes. We focus particularly on the factors influencing the adoption of a specific class of software tools called Innovation Management Software (IMS) or Digital Innovation Management System to support innovation management methods and activities. Specifically, we address the two questions (a) which specific functionality drives the adoption of IMS tools, and (b) which services of IMS providers are valuable in supporting the adoption of IMS by organizations aiming to digitalize their innovation processes. By using an online questionnaire, we gathered survey data from 199 innovation managers of German firms. We used regression analysis to test our hypotheses. While the overall IMS adoption is considered to positively affect the new product development (NPD) efficiency, our results indicate that especially idea management functionalities and services for updates and upgrades improve the IMS adoption. Surprisingly, offering complementary consulting services together with IMS offerings to support the digitalization of innovation processes reduces the likelihood of IMS adoption. These findings are important for managers, consultants, and developers in order to choose and leverage the right options for improving the adoption of IT tools in the NPD process and therefore increase NPD performance and thus also promote Entrepreneurial Ecosystems.

Keywords Adoption · Digitization · Digital transformation · Digital innovation management system · Entrepreneurial ecosystem · Innovation management · Digital services · New product development performance

JEL Classification O31

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1 Introduction

"Digital innovation is the use of digital technology during the process of innovating" (Nambisan et al. 2017: 223). Digital innovation triggers the creation or change of products, processes, or business models and transforms entire industries (Bouncken et al. 2019; Endres et al. 2015, 2019b; Kraus et al. 2019; Laudien and Pesch 2019; Nambisan et al. 2017). Digitization has a particular impact on new product development (NPD) because NPD is a knowledge and information-intensive business process (Wee et al. 2015). For instance, Unilever's Innovation Process Management System or SAP with their cloud based "Innovation Management" product illustrate this substantial impact of digitization on NPD. To explore these digital NPD processes, the emerging literature stream on digital innovation management is calling for further research in this area (Huesig and Endres 2019; Kawakami et al. 2015; Kohli and Melville 2019; Lanzolla et al. 2020; Mauerhoefer et al. 2017; Pesch and Endres 2019; Pesch et al. 2018; Reid et al. 2015).

Previous research has highlighted the digitization of innovation processes and outcomes, especially with regard to the beneficial impact of information technology (IT) on NPD (Barczak et al. 2007; Durmuşoğlu et al. 2006; Durmuşoğlu and Barczak 2011; Heim et al. 2012; Kawakami et al. 2015; Mauerhoefer et al. 2017; Nambisan 2003). Durmusoğlu (2009) suggested that the IT infrastructure capability could enhance NPD process efficiency by reducing the cycle time and cost of NPD projects and by improving the NPD process quality. Further, NPD Management Software can promote the coordination in entrepreneurial ecosystems (EEs) that consist of a "set of interdependent actors and factors coordinated in such a way that they enable productive entrepreneurship within a particular territory" (Cavallo et al. 2019: p. 1300). NPD Management Software can support the consolidation of an organization's innovation programs, stakeholders and resources in one place. Scholars such as Heim et al. (2012), Durmuşoğlu and Barczak (2011), and Mauerhoefer et al. (2017) tested such propositions and reported positive impacts on NPD outcomes.

Specific research gaps remain with regard to the determinants of NPD software adoption and usage. Most studies deal with two issues. On the one hand, they investigate how NPD tools can influence and improve the innovation process (Durmuşoğlu and Barczak 2011; Heim et al. 2012; Mauerhoefer et al. 2017; Kroh et al. 2018). The level of digital transformation in Product-Lifecycle-Management (PLM) positively influences structural and relational performance and, in turn, enhances NPD performance (Schweitzer et al. 2019). On the other hand, researchers studied context factors of the process and project aspects on the adoption of the IT in the innovation process (e.g., Barczak et al. 2007; Mauerhoefer et al. 2017) while treating the technical aspects like a black box. Mauerhoefer et al. (2017: p. 16) point out that "it would be interesting to explore whether there are certain IT tools or IT functionalities that are important for NPD managers steering one or multiple NPD projects."

Thus, the empirical NPD research so far has largely failed to investigate the influence of specific functionalities or types of the IT support in the innovation process. Therefore, existing studies might be of limited benefit for such as innovation managers or developers of IT tools, because of their overly generic approach and results (Huesig and Endres 2019). In the context of EEs, Autio et al. (2017) explicitly emphasize that future research should identify a more granular consideration of specific digital infrastructures and technologies. This research focus may offer more nuance on how to create digital affordances and shape entrepreneurial ecosystem structures and outcomes.

Thus, managers do not know which IT tools provide value under which specific context rather than that IT tools are beneficial in general (Durmuşoğlu and Barczak 2011). This is an important and relevant issue because it means that managers and their firms currently have only a limited understanding of how to allocate their resources for digital innovation management. Therefore, more detailed knowledge is needed that informs managers about which category or class of particular IT tools can serve as levers for improving certain performance metrics of NPD. In other words, what functionality is really a key ingredient for the innovation practitioner when they decide on IT adoption.

In this paper, we highlight the digitalization of innovation processes. We focus particularly on the factors influencing the adoption of a specific class of software tools called Innovation Management Software (IMS) or Digital Innovation Management System to support and digitalize innovation management methods and activities. Specifically, we address the two questions (a) which specific functionality drives the adoption of IMS tools, and (b) which services of IMS providers are valuable in supporting the adoption of IMS by organizations aiming to digitalize their innovation processes in their respective EEs.

Moreover, in recent years, the importance of services has increased because of a growth of homogeneous products (Cho et al. 2012; Endres et al. 2019a). Therefore, many companies have started to offer services in addition to their products in order to stand out from their competitors (Endres et al. 2019a; Yen et al. 2012). These service offerings can lead to an increase in their earnings potential (Cusumano 2007). Software companies also frequently offer consulting services prior to the adoption or installation of new IT tools for the innovation process (Gronau 2012). IMS firms such as Innolytics or Hype Innovation show that IMS providers also attach great importance to services they offer to companies (Innolytics 2020; HYPE 2020). Services such as consulting and maintenance services (Buxmann et al. 2011), software installation, training, and customizing (Cusumano 2007) are often offered in addition to the software product. However, besides this frequent practice, it remains unclear as to which of these services are really helping to foster the adoption of IMS in the innovation process.

To close this highly relevant gap, we used an online questionnaire and gathered data from 199 innovation managers of German firms. We analyzed the resulting data by using both logistic and ordinary least squares regressions.

Our paper aims to make the following contributions to the body of digital innovation management and entrepreneurial ecosystem knowledge: while we find that the overall IMS adoption is considered to positively affecting the NPD efficiency, our results indicate that especially idea management functionalities and services for updates and upgrades improve the IMS adoption. Surprisingly, offering complementary consulting services together with IMS offerings to support the digitalization of innovation processes tends to reduce the likelihood of IMS adoption. The present study brings with IMS a new aspect into the emerging research on digital innovation and their antecedents. Beyond this, our findings on IMS adoption provide valuable insights for theory development in the emerging research field of EEs. Finally, our findings are important for helping managers, consultants, entrepreneurs, and developers to choose and leverage the right options for improving the adoption of IT tools. The digitization of innovation management supports the coordination in EEs and, in turn, increase NPD performance.

We structured our paper as follows. First we provide the theoretical foundation for our model. Second, we develop the hypothesis related to functionalities, services, IMS adoption and NPD performance. Third, we explain our data and method in detail. Fourth, we present the results and discuss their implications for research and practice. Finally, before we summarize the key insights for digital innovation management and EEs of our study, we provide our study's limitations and avenues for future research.

2 Theoretical background and hypothesis development

2.1 Entrepreneurial ecosystems and information technology

With the occurrence of digital technologies, research argues that innovations are increasingly becoming an outcome of interactions between a firm and various other organizations (Beliaeva et al. 2019; Bouncken and Barwinski 2020; Czakon et al. 2020; Kraft et al. 2020; Liguori et al. 2019). It is hardly possible for a single actor to provide a complete solution that meets all their clients' expectations in the digital age (Ferreira et al. 2019a). To source and integrate different resources, EEs can have a crucial role for (digital) innovations (Kang et al. 2019; Sussan and Acs 2017). The complexity of relationships and interdependencies is an inherent element of EEs (Cavallo et al. 2019). The emerging information technologies have the potential to increase the coordination complexity because they provide a plethora of new possibilities for how to connect different ecosystem actors though enhancing collaboration across time and space (Kraus et al. 2019). These new collaboration possibilities can, however, result in high innovation and entrepreneurial potentials (Sussan and Acs 2017). A major challenge of EEs is therefore the effective and efficient combination and alignment of the different actors' resources and innovation programs to leverage these potentials (Colombo et al. 2019). IT has a double-edged role for the coordination in EEs. On the one hand, it leverages the coordination complexity but on the other hand, the application of IT might be a means to support coordination in EEs.

2.2 Digitization of the NPD process through IMS

The digitalization of the innovation process is driven by rapidly advancing IT hardware and communication tools as well as by a growing supply of specialized software applications that supports a rising number of NPD activities and innovation methods (Huesig and Endres 2019; Nambisan et al. 2017; Nijssen and Frambach 2000). Previous research has highlighted the digitization of innovation processes and outcomes especially with regard to the impact of IT on NPD or the digital transformation in Product-Lifecycle-Management (PLM) in more general terms (e.g., Schweitzer et al. 2019; Barczak et al. 2007; Durmuşoğlu et al. 2006; Heim et al. 2012; Kawakami et al. 2015; Mauerhoefer et al. 2017; Nambisan 2003). In our study, however, we focus on a specific class of software tools for supporting the digitalization of innovation management methods and activities in NPD, called Innovation Management Software (IMS).

IMS can be understood as a specific sub-field of Computer Aided Innovation (CAI). IMS aims to emphasize the innovation management aspects in the innovation process that were previously often classified as CAI tools or were largely ignored (Huesig 2015; Huesig and Kohn 2009; Huesig and Waldmannstetter 2013). These software tools regularly facilitate or include Employee Suggestion Systems (ESS) and idea management processes (Huesig 2015). In the German context, "HYPE Improve" by HYPE Softwaretechnik GmbH is an example for a better-known IMS tool that offers a comprehensive solution for the management of ideas targeting cost saving opportunities and process improvements (Huesig 2015). Other IMS offers integrated solutions that widely capture the NPD process in a digital system, including shared databases of workplans, schedules, product designs, project planning documents, and project histories. These solutions support knowledge integration (Durmuşoğlu and Barczak 2011) and promote flexibility, agility and rapid communication between different actors in EEs, especially in an Open Innovation context (Huesig 2015). Sopheons Accolade, ID, or Hype IMT fit into this category. IMS developers aim to provide an even greater degree of comprehensiveness with regard to their organizational integration capabilities to digitally connect all relevant NPD processes across different business units and departments and associated other firm process and systems such as suppliers with their IMS system. Thus, IMS can also be seen as a part of infrastructure for EEs (Stam and van de Ven 2019). IMS can support the coordination and alignment of the different ecosystems actors' new innovation processes. Unilever's Innovation Process Management System or SAP, with their cloud based "Innovation Management" product, support a high level of digital maturity in the NDP. In the literature, the potential benefits of these types of IT tools are discussed in dimensions such as efficiency, effectiveness, competence, and creativity enhancing; however, empirical studies on their actual usage or adoption remain scare (Huesig and Endres 2019).

2.3 IMS functionality and functional classification

Due to the often individually designed functionality of the various IMS applications, it is necessary to define functional classifications. Thus, Huesig and Waldmannstetter (2013) defined functional classifications of IMS as fields of activities in the innovation process. In order to redefine the functional range of IMS tools, a subdivision of the functional classifications is based on generic NPD-activities. We apply Huesig and Waldmannstetter's (2013) classification framework for IMS in the present study to define functional classifications around the categories "idea management", "product management" and "strategy management".

The functional category "idea management" and related idea management systems such as ESS were developed from simple mind maps or electronic suggestion boxes into systems to store, display, and organize the submitted ideas (Westerski et al. 2011). Contemporary systems focus on defining a formalized software-aided idea management process that is well defined, traceable, and repeatable (Westerski et al 2011). The "idea management" category includes the idea management process, which includes core activities in the front end of NPD.

The functional category "product management" includes product definition and product development as the core activities such as review of product concepts, project development decisions using a structured process such as a Stage-Gate™, concept and platform development, project portfolio management, business case, and investment analysis or road mapping (Cooper and Edgett 2010).

The functional category "strategy management" encompasses tools that help innovation managers to deal with strategic issues in the innovation process such as strategic portfolio management, strategic objectives, scenario planning, and business support functions as enablers for strategy management tasks (e.g., knowledge management, business intelligence, document management, data warehousing, etc.) (Cooper and Edgett 2010).

2.4 Services for software and IMS

As mentioned before, software firms frequently offer various complementary services prior to and after the adoption or installation of their products at their customer's organizations. IMS firms such as Innolytics or Hype Innovation, show that IMS providers also attach great importance to services they offer to companies (Innolytics 2020; HYPE 2020). IMS firms provide services such as consulting and maintenance services, software installation, training, and customizing (Buxmann et al. 2011; Cusumano 2007) in addition to the software product.

Software companies often offer consulting services prior to the adoption or installation of new IT tools (Gronau 2012). These are regarded as an important quality feature because they can have a significant influence on the success of a service offering (Fähnrich and van Husen 2008). IMS firms thus provide content and technical support, for instance, for optimal product selection (Innolytics 2020; HYPE 2020). This advice can help a customer or company make the right decision (Stiller 2006) to select the best product for their particular needs. In this case, companies could particularly benefit from the knowledge of the software providers, especially if there is uncertainty about the multitude of software or IT products or tools. This can also be important for small and medium-sized enterprises, as they usually have less IT expertise (Buxmann et al. 2011). In addition, software companies also offer advanced consulting on the design and digitalization of the innovation process. At this point, IMS firms as external consultants are occasionally added to provide companies with qualified know-how and support in the digitalization of their business processes (Innolytics 2020). Since the innovation process is also significantly influenced by digitalization (Huesig and Endres 2019), it seems logical for IMS providers to offer such consulting services in addition to their products. In this way, they can develop a strategy for an innovation process during digital change together with their customers or companies. If a company experiences such advice as a customer, this can increase its satisfaction with the IMS provider and a satisfied customer can thus be bound to the company.

Software companies often also offer assistance with the installation and configuration of new IT tools in order to adapt them to the existing hardware or software infrastructure of the company (Gronau 2012). For example, companies such as Microsoft or SAP are bringing standard solutions onto the market and tailoring these during the implementation phase to company-specific processes (Kortzfleisch et al. 2014). This is necessary because companies often have different processes and structures to which a standard solution must be individually adapted (Mertens et al. 2017). This can be summarized under the term customizing, which refers to a special adaptation of standard software to the needs of the company (Kortzfleisch et al. 2014) and is regarded as very important (Buxmann et al. 2008). A basic distinction can be made between three different forms: parameterization, configuration, and supplementary programming (Leimeister 2015). In parameterization, the full functional scope of the standard solution is reduced to the required functional scope by individual parameters. During configuration, on the other hand, only the desired range of functions is implemented in the software. The most expensive variant is supplementary programming, in which the desired extensions are programmed as additional software in addition to the standard software. Customizing is important because it can influence customer satisfaction (Wang et al. 2010), which in turn has a direct effect on customer loyalty (Hallowell 1996). The latter then leads to a sustainable interaction with the customer (Pan et al. 2012), from which a company or a software provider can benefit greatly, because a loyal customer will remain with the company in the long term.

With regard to maintenance services, software providers offer updates and upgrades that update programs on an ongoing basis (Schön 2018) and implement new functions (Urbach and Ahlemann 2016). In recent years, companies have spent more and more money on updates, upgrades, and extensions (Capgemini Deutschland 2017). On the one hand, updates are necessary to close security gaps in the software; otherwise, a company becomes vulnerable (Becher 2015). On the other hand, the company's IT infrastructure can also change, to which the software can or must be adapted by means of an update. However, an upgrade can also include new functions (Fleischmann et al. 2016). However, an upgrade must provide an actual new benefit for the customer (Choudhary 2007); otherwise, the customer may not accept or implement the extension. The advantage for companies results from a better efficiency of the new functionalities of the updated software (Beatty and Williams 2006). New functions could continuously improve and simplify business processes or, in particular, the innovation process. However, software providers do not offer such services altruistically because they profit from the sale of new upgrades (Min Khoo and Robey 2007). They indirectly force companies to update their older software or to upgrade and buy by no longer supporting the old software (Min Khoo and Robey 2007). For example, compatibility with existing hardware can be restricted and the software would no longer be given a new feature set. Software vendors could therefore generate new revenues when companies need to buy new upgrades.

Another component of complementary services for software is training. The aim is for customers or companies to be able to handle a new product without problems (Prandini et al. 2018). Training gives actors in EEs the opportunity to generate new information from feedback and suggestions from each other so that products can be improved. This could help actors in EEs to increase their sensing capability (Endres et al. 2020), which is one dimension of the dynamic capabilities that increase the adaptability of firms (Endres 2018). With regard to software and IT tools for the innovation process, employees of a company in particular need assistance in the form of training (Schallmo et al. 2017). For example, the employees of a company who use the software or IT tools for the innovation process can learn how to use the tools most effectively through learning programs or training workshops (Innolytics 2020). In addition, users can benefit from the knowledge of the software providers and apply it (Waldmannstetter and Huesig 2009). This enables less experienced users to better understand the supported innovation methods. This service would be particularly useful if managers in the innovation process themselves had little experience with the new tools and thus needed sound external help (Huesig and Kohn 2009).

Although customer support and service are often used synonymously (Goffin and New 2001), customer support is once again regarded as an independent service. If one starts from the private sector, customer support is also understood as a separate service. The task of customer support is to solve customers' individual problems (Claro and Ramos 2018). It is particularly important in the after-sales phase, as this enables companies to retain customers (Bruhn 2011). An example of customer support can be online support or telephone support (Goffin and New 2001). For example, software providers can help if companies have problems using software or IT tools for the innovation process.

2.5 Development of hypothesis

On a more general level, the benefits of the digital transformation are typically seen to lead to improvements on productivity, innovation in value creation and in the development of customers' interaction (Endres et al. 2019b; Kraus et al. 2019). Moreover, Ferreira et al. (2019a, b) show that entrepreneurs' and managers' profiles and these leaders' adoption of new digital processes contribute to these companies' greater competitiveness. Since the complexity of relationships and interdependencies is an inherent element of EEs, new collaboration possibilities enabled by information technologies can result in high innovation and entrepreneurial potentials (Cavallo et al. 2019; Sussan and Acs 2017). A major challenge of EEs is therefore the effective and efficient combination and alignment of the different actors' resources and innovation programs to leverage these potentials (Colombo et al. 2019). Regarding the digitalization of innovation processes in particular, several studies claim that digital tools positively affect the firm's NPD performance including its NPD effectiveness and NPD efficiency (Heim et al. 2012; Durmuşoğlu and Barczak 2011; Mauerhoefer et al. 2017). The digital infrastructure could enhance NPD process efficiency by improving the coordination between and knowledge exchange across different actors resulting in reduced cycle time and NPD project costs as well as improved NPD process quality. However, what has not been empirically tested so far is if this is also the case specifically for IMS adoption and NPD performance. As outlined above, we would argue that the adoption of these types of IT tools in the NPD by the organization is a precondition to reap potential benefits of digitalization in the innovation process and in particular in EEs with its inherent coordination and alignment complexities. In the context of EE, a more granular consideration of specific digital technologies that positively influence entrepreneurial ecosystem structures and outcomes could be beneficial for research and practice in this regard (Autio et al. 2017). These potential benefits are efficiency, effectiveness, which are discussed in the literature and claimed by the developers of these digital tools and related theoretical literature (Huesig and Kohn 2009; Huesig and Waldmannstetter 2013). Moreover, given that IMS is appropriately embedded in the NPD activities and processes, a higher degree of innovation capability in the organization is expected that in the end also contributes to the innovation success of firms. Therefore, we would assume the following:

H1: IMS adoption is positively related to NPD performance.

Ferreira et al. (2019a, b) show that entrepreneurs' and managers' profiles and these leaders' adoption of new digital processes contribute to the companies' greater competitiveness in general. Given that the IMS adoption is in fact positively related to NPD performance, as assumed above, the role of the functional categories of IMS tools for the acceptance and benefits from the perspective of the user remains largely unclear. Therefore, the characteristics of IMS as means to digitize the innovation process needs to be illuminated. So far, a comprehensive analysis of the demand side of IMS is very rare. To explore which factors influence the adoption of IMS, we develop a hypothesis regarding the functional categories of IMS. To do so, we use the IMS categories based on Huesig and Waldmannstetter (2013). In their study the majority of the IMS tools analyzed was categorized as "Specialized Products". This category includes IMS products that support, at least in part, only one of the functional categories. These IMS tools typically focus on a single functional group and on selected sub-functions products, similar to stand-alone or isolated solutions in the CAI category (Huesig and Kohn 2009). One could argue that this could change over time towards more integrated solutions and just represents a snapshot of a certain market situation. However, even if this stance were taken, it would be important for the developers of IMS to understand which functionalities of IMS are most relevant for the adoption of the software to focus their attention on. Therefore, we suggest our second hypothesis to explore the adoption of IMS with regard to functional categories:

H2: IMS adoption is positively related to specific functional categories.

Software companies frequently offer various types of services, such as consulting, maintenance and update programs on an ongoing basis prior to the adoption or installation of new digital tools (Gronau 2012; Schön 2018). IMS firms such as Innolytics or Hype Innovation, show that IMS providers also offer related services to customer companies to digitize the innovation process (Innolytics 2020; HYPE 2020). Besides this frequent practice and various support of services being helpful complementing software products, it remains unclear which of these service types (consulting, training, customer support, customizing, updates and upgrades) have (the strongest) positive influence to foster the adoption of IMS in the innovation process. The developers of IMS to focus their attention on understanding which service categories for IMS are most relevant for the adoption of the software to focus their attention on. Therefore, we suggest our third hypothesis to explore the adoption of IMS with regard to service categories:

H3: IMS adoption is positively related to specific service categories.

3 Data and method

3.1 Research setting and data collection

199 German firms provide the data basis for this study. To gather the data, we, first, randomly preselected 1300 firms with more than 50 employees from the DAFNE firm database since very small companies usually do not consider IMS (Kohn and Huesig 2006). In the second step, we contacted innovation managers from these firms via email, phone, and the business platforms Xing (leading German business platform) and LinkedIn. Finally, before we sent our questionnaire to our sample, we pretested it with innovation managers who were not in our final sample. From 550 personally contacted innovation managers, we received 199 usable questionnaires, which equals a response rate of 36%. It took about six months to collect all data. Innovation managers typically fulfill various roles in their organisations, amough them to orchestrate the innovation processes in the EE (Gernreich et al. 2018; Sim et al. 2007). Therefore they are key informants in their respective organisations especially in the era of open innovation and EE. On average, our respondents are 9.6 years in their current innovation management position. 45% of the firms of our respondents use IMS and 55% does not use this kind of software. The sample covers a broad range of firms: 19% > 10,000 employees; 24% 1000–10,000 employees, 19% 250–1000 employees, and 38% < 250 employees.

3.2 Measurement and analysis

We developed the questionnaire based on a review of the literature on IT tools/software for NPD and innovation management, websites from international innovation management software providers, and related research fields, in-depth interviews, and a survey pretest (Gerbing and Anderson 1988). Therefore, we were able to validate the content and refine the adapted scales and questionnaire for clarity and specificity, which included content evaluation and editorial suggestions (DeVellis 2016). We then pretested this adapted, structured questionnaire on diverse research experts from the academic field and top managers not included in our survey sample. This procedure is similar to the approach from Endres et al. (2020). We illustrate the used items from our key variables in Table 1.

For IMS adoption, we created a dummy variable for the measurement, whereby code 1 is used when the innovation manager responded that the firm has adopted IMS and 0 when it has not. For NPD performance, we derived the Likert-scales from Mauerhoefer et al. (2017), including the measures NPD effectiveness and NPD efficiency from Brettel et al. (2011). To derive the IMS key functional and service categories we reviewed websites from international innovation management software providers and combined these insights with existing research knowledge from the field of IMS tools. This procedure is similar to the approach from Huesig and Endres (2019) and Huesig and Waldmannstetter (2013). The key functional categories are idea management, product management, and strategy management. As key service categories we used consulting, training, customer support, customizing, and updates and upgrades. We applied five-point Likert-scales to capture the importance of these key functional and service categories. We listed all items of these variables in the Appendix. We validated this information by considering objective data from business reports and company website. We conducted a confirmatory factor analysis to assess the measurement properties of the multidimensional scales (Falke et al. 2020). The results indicate good overall fit (confirmatory fit index > 0.90, Tucker–Lewis index > 0.90, root mean square error of approximation < 0.08). Our measurement properties also suggest constructs' convergent validity [average variance extracted (AVE) > 0.6, composite reliability > 0.7] and their discriminant validity, according to the comparison of the AVE with their highest squared correlation (Bagozzi and Yi 2012). Table 2 illustrates the descriptives and intercorrelations of our variables.

First, we used an ordinary least squares regression analysis for our analysis of the relationship between IMS adoption and NPD performance including NPD effectiveness and NPD efficiency (H1). This is in line with Cohen et al. (2003) who recommend this procedure to predict a continuous dependent variable, what applies to NPD effectiveness and NPD efficiency, from one or more independent variables. Similar to Smith et al. (2005) we include firm size as control variable in this analysis and measure it as the log of the number of employees. Second, for the analysis of the relationships between the independent variables IMS key functional (H2) and key service categories (H3) and the dependent variable IMS adoption, we used a binary logistic regression because IMS adoption is a nominal variable. This is necessary because the observed variables do not have a linear relationship. Logistic regression

Table 1 Measures of variables

IMS adoption (adapted from Huesig and Endres 2019)
Does your company use a software for innovation management? (*Yes/No*)
NPD efficiency [derived from Mauerhoefer et al. (2017) and Brettel et al. (2011)]
In the next question, please think of a representative project from the past two years that has gone through the entire innovation process from idea to market launch
Please indicate to what extent you agree or disagree with the following statements (*1 = agree not at all; 5 = totally agree*)
1. The development phase was shorter than we expected
2. The commercialization phase was shorter than we expected
3. We accomplished market introduction as scheduled
4. The market introduction was in line with the budget projected
5. The new product development was in line with the budget projected
6. Overall, considering all aspects, the project was a success

NPD effectiveness [derived from Mauerhoefer et al. (2017) and Brettel et al. (2011)]
In the next question, please think of a representative project from the past two years that has gone through the entire innovation process from idea to market launch
The new product, which has gone through the innovation process, fulfills all objectives with regard to…(*1 = agree not at all; 5 = totally agree*)
1. Profits/ROI
2. Revenue
3. Competitive advantage
4. Market share

Please indicate how important the following aspects of a software for innovation management are/would be for your company [*1 = not at all important; 5 = very important*) (items developed based on the procedure from Huesig and Endres (2019) and Huesig and Waldmannstetter (2013)]*:*
Idea management
Idea categorization
Idea selection
Idea evaluation
Product management
shortterm portfolio management
Product and project overview
Operative product/project planning
Investment calculations
Strategy management
Business intelligence
Longterm portfolio management
Strategic planning
Scenario management
Please indicate how important the following services of a provider for innovation management software are/would be for your company? (*1 = not at all important; 5 = very important*) [items developed based on the procedure from Huesig and Endres (2019) and Huesig and Waldmannstetter (2013)]*:*
Consulting
Training
Customer support
Customizing
Updates and upgrades
Firm size [derived from Smith et al. (2005)]
How many employees work in your company?

overcomes the problem of violating the assumption of linearity because it represents the multiple linear regression equation in logarithmic terms (Berry 1993). We applied SPSS 25.0.

Table 2 Descriptives and intercorrelation matrix

	1	2	3	4	5	6	7	8	9	10	11	12
1. Idea management	1.00	.48**	.44**	.33**	.30*	.25	.36**	.24	.21*	.03	.17	.29*
2. Product management	.48**	1.00	.73**	.35**	.41**	.36*	.32*	.49**	.27**	− .07	.34*	.28
3. Strategy management	.44**	.73**	1.00	.31*	.38**	.33*	.30*	.40**	.29**	− .01	.23	.12
4. Consulting	.33**	.35*	.31*	1.00	.52**	.40**	.55**	.59**	− .21	.03	.06	− .03
5. Training	.30*	.41**	.38**	.52**	1.00	.66**	.51**	.64**	− .09	.09	.15	.03
6. Customer support	.25	.36*	.33*	.40**	.66**	1.00	.56**	.73**	.03	.05	.11	− .09
7. Customizing	.36**	.32*	.30*	.55**	.51**	.56**	1.00	.48**	− .24*	.16	− .01	− .27
8. Updates and Upgrades	.24	.49**	.40**	.59**	.64**	.73**	.48**	1.00	.16	.01	.16	.08
9. IMS adoption	.21*	.27**	.29**	− .21	− .09	.03	− .24*	.16	1.00	.30**	.13	.36*
10. Firm size	.03	− .07	− .01	.03	.09	.05	.16	.01	.30**	1.00	.11	.20
11. NPD effectiveness	.17	.34*	.23	.06	.15	.11	− .01	.16	.13	.11	1.00	.57**
12. NPD efficiency	.29*	.28	.12	− .03	.03	− .09	− .27	.08	.36*	.20	.57**	1.00
Mean	2.92	2.76	2.83	3.83	3.84	4.19	3.69	4.00	.36	3.06	3.37	3.12
SD	1.19	1.06	1.05	1.20	1.08	1.01	1.22	.87	1.07	1.08	.79	.82

*$p < .05$ (two-tailed)

**$p < .01$ (two-tailed)

4 Results and discussion

4.1 Results

Table 3 illustrates the results from both regression analyses. For our first analysis, the values of the R^2 of the IMS adoption and the NPD effectiveness (0.02) and NPD efficiency (0.17) indicate the high relevance of IMS particularly for NPD efficiency. In our second analysis, the R^2-values (R^2-Cox: 0.36; R^2-Nagel: 0.41) support the importance of the key functional and key service categories for IMS adoption.

For H1, the IMS adoption has a positive significant influence on NPD efficiency ($\beta = 0.39$; $p \leq 0.01$) but no significant effect on NPD effectiveness ($\beta = 0.11$; $p > 0.10$). Thus, H1 can only be partly confirmed. H2 can also only be partly confirmed because the only significant effect exists for the relation between idea management and IMS adoption ($B = 1.52$; $p \leq 0.01$). For the hypotheses H3, our results can only support the suggested influence of updates and upgrades on IMS adoption ($B = 1.55$; $p \leq 0.05$). Surprisingly, the effect of the key service category Consulting on IMS adoption is even negative and thus stands in contrast to our hypothesis H3.

Table 3 Hypotheses testing and controls based on regression results for IMS adoption and NPD performance

	Path from	To	Results	ß/B values	Odds ratio	*p* values
H1a	IMS adoption	NPD effectiveness	Not significant	.11	–	.27
H1b	IMS adoption	NPD efficiency	Supported	.39***	–	.01
Functionalities						
H2a	Idea management	IMS adoption	Supported	1.52***	4.58	.01
H2b	Product management	IMS adoption	Not significant	.15	1.17	.42
H2c	Strategy management	IMS adoption	Not supported	.04	1.04	.48
Services						
H3a	Consulting	IMS adoption	Not supported	– .81**	.45	.05
H3b	Training	IMS adoption	Not significant	– .43	.65	.24
H3c	Customer support	IMS adoption	Not significant	– .36	.70	.28
H3d	Customizing	IMS adoption	Not significant	– .57	.57	.11
H3e	Updates and upgrades	IMS adoption	Supported	1.55**	4.71	.05
Controls						
	Firm size	NPD effectiveness		.06		.73
	Firm size	NPD efficiency		.04		.81

*$p \leq .10$.; **$p \leq .05$.; ***$p \leq .01$

Significance tests are one-tailed for hypothesized relations and two-tailed for controls

The results of our study so far show some supportive evidence on the general notion of digital innovation management as well as the role of IMS in this context and brings a new aspect into play in the emerging research on EEs: the role of IMS. We find that IMS support tends to improve the NDP efficiency that is in line with similar findings on other IT support in the innovation process (Barczak et al. 2007; Durmuşoğlu et al. 2006; Durmuşoğlu and Barczak 2011; Heim et al. 2012; Kawakami et al. 2015; Mauerhoefer et al. 2017; Nambisan 2003). However, IMS is no panacea and cannot (so far) substitute human creativity. Our results regarding the insignificant effect on effectiveness are in line with the IMS and CAI literature (Leon 2009; Huesig 2015; Huesig and Kohn 2009).

4.2 Discussion

4.2.1 Theoretical contributions

In contrast to the previous assumptions in literature, our results indicate that the likelihood of IMS adoption by innovation managers is positively influenced if the IMS tools offer support for the specific functionality for idea management but not for product and strategy management. This could be related to previous findings such as Huesig and Endres (2019) that innovation managers want to have control on making decisions and that creativity is created elsewhere (not in the management of the process).

Therefore, innovation managers need to get support to enhance efficiency by IMS where the quantitative workload to manage is the highest, since the number of ideas is typically higher than the number of the resulting approved innovation projects in the later stages of the process (Huesig and Waldmannstetter 2013). An alternative interpretation of the non-significant influence of the other IMS functional categories on IMS adoption could be the degree of innovation management capabilities or maturity of the firms that might moderate the desire for more advanced IT support in the form of IMS (Huesig 2015; Huesig and Kohn 2009; Huesig and Waldmannstetter 2013). Typically, IMS support is strong in the idea management area (Huesig and Waldmannstetter 2013).

Our findings indicate that offering complementary services prior to and after the adoption or installation of IMS by software suppliers does not lead to higher adoption in every case. In fact, only updates and upgrades show a positive effect. Instead, selling additional consulting services has a negative effect. At the first glance this might seem contradicting most of the service-related literature (e.g., Buxmann et al. 2008; Wang et al. 2010; Pan et al. 2012). However, this finding also needs to be reflected in combination with the other results and put in perspective with the literature on the IMS supply in general: first, it seems that only few functional categories are important for adoption, such as idea management, and these tools tend to be less sophisticated in comparison with more integrated solutions (Huesig and Waldmannstetter 2013). This could mean that there is less need for more sophisticated services such as consulting, training and customer support or customizing. It could also be seen as a desire to adopt IMS tools that are self-explaining and are simple to use and understand. The underlying variable might be the complexity of the IMS per se if these services are a relevant factor for adoption. Second, the software delivery has changed from on premise to on demand as "Software as a Service" (SaaS) and is easier to integrate into the IT infrastructure and less customer support or customizing is needed (Benlian et al. 2009; Kaltenecker et al. 2013, 2015). However, a closer look into these relationships and further conceptual work is needed.

Our study also enriches the emerging research on entrepreneurial ecosystems. We emphasized IMS as a crucial part of the infrastructure of EEs (Stam and van de Ven 2019) that promotes the coordination of and alignment of the different actors' knowledge, resources and innovation programs. Therefore, we suggest that IMS seem to resemble some of the specific digital infrastructures and technologies that create digital affordances and shape entrepreneurial ecosystem structures and outcomes as Autio et al. (2017) called for.

4.2.2 Managerial implications

Our findings provide valuable insights to actors involved in EEs such as managers, consultants, entrepreneurs, and developers. The effective and efficient combination and alignment of the different actors' resources and innovation programs is the major challenge in EEs. These different actors need to know how to choose and leverage the right options for improving the adoption of IT tools that can support the coordination in EEs. This is particularly relevant for firms and innovation managers who intend to foster their digitalization agenda regarding the innovation process by adopting IMS or want to align the development of IMS closer to the actual user needs in EEs.

Developers, product and marketing managers of IMS can use our results to focus on the few functional categories that are important for adoption. Specifically, idea management and services such as updates and upgrades really seem to matter to the adopters. Future research might clarify how practioners should apply IMS to improve idea generation in EEs and identify the boundary conditions of its beneficial usage. Our findings also prevent software firms or internal developers to invest in additional consulting services that potential adoptors more alienate that appreciate. Software support and consulting services seem to be distinctive competencies in the context of the digitalization of the innovation process and seem to be better coordinated separately in the EE.

4.3 Limitations and future research opportunities

Our study has a number of limitations that provide opportunities for further research. First, it is based on a cross-sectional and quanitative research design that is reductionistic in nature and focus on a specific point of time in the evolution of the underlying technology of IMS and the empirical field. Qualitative research could help to further illuminate and illustrate the how and why of the IMS adoption with regard functionality and services or other factors that were not addressed here. Further, other aspects of the software that were omitted in this study could be examined.

Especially, different types of IMS could be studied in more detail and context to get a more detailed understanding and discover potential underlaying factors such as complexity of IMS that are overlooked in larger samples. Moreover, the decision structures inside the organisations which lead to adoption and use of IMS to digitalise the innovation process remain largely unknown. Moreover, our sample is regionally focused on German firms. Future studies should consider other markets and institutional contexts to test and expand the external validity of our findings. Especially the preferences and expectations regarding complementary services might vary in other contexts.

Further, more theoretical work and empirical research is needed to clarify the merits but also challenges of IMS in EEs. An important aspect might be contextual factors such as the kind of digital technology to which the innovation process is related or specific characteristics of EEs such as the number and type of actors or the quality and quantity of relationships in the EE. Such contextual factors might affect the impact of IMS and its adaption. For instance, a large and heterogenous EE that has emerged around the 3D printing technology might differ in its coordination and IMS adaption compared to a small and homogenous EE that is related to artificial intelligence. Finally, a future research study that compares ecosystem actors who use IMS with those who don't use IMS may also be fruitful to ascertain the impact of such software on ecosystem management and engagement. The linkage between IMS and EEs creates a promising field for future entrepreneurship research that is still diversifying and identifying new subfields (Ferreira et al. 2019a, b).

5 Conclusion

Overall, our findings should advance the understanding of technological and organizational drivers of the transformation towards the digitalization of the innovation process. To do so, we explore the influencing factors on the adoption of IMS, a specific class of software tools to support and digitalize innovation management methods and activities. In detail, we have addressed two questions in this paper (a) which specific functionality drives the adoption of IMS tools, and (b) which services of IMS providers are valuable to support the adoption of IMS by organizations which aim to digitalize their innovation processes in their respective EE.

By using an online questionnaire, we gathered survey data from 199 innovation managers of German firms. Innovation managers typically fulfill various roles in their organisations, amough them to orchestrate the innovation processes in the EE. We used regression analysis to test our related hypotheses. Our results supported previous findings that emphasize the benefits of digitalization in the innovation process as also IMS support tends to improve the NDP efficiency. In order to reap these benefits the adoption of IMS tools is a precondition.

We could show that primarly idea management functionality and services to update and upgrade drive the adoption of IMS but consulting influences it negatively. Therefore, we conclude that the innovation managers' preference for idea management functionality could be explained by their desire to have control on making decisions and that creativity is created elsewhere (not in the management of the process). In accordance with this, innovation managers need to get support to enhance efficiency by IMS where the quantitative workload to manage is the highest. The number of ideas is typically higher than the number of the resulting approved innovation projects in the later stages of the process.

The positive influence of simple services such as updates and upgrades and the negative effect of additional consulting services on IMS adoption could be explained by the innovation managers' preferences. Innovation managers prefer less sophisticated and easy to use digital solutions with no need for more sophisticated services such as consulting, training and customer support or customizing. IMS tools that are self-explaining, simple to use and to integrate into the IT infrastructure in order to increase the efficiency of the innovation process seem to explain the more successful adoption. These findings are particularly relevant for firms, entrepreneurs, and innovation managers who intend to foster their digitalization agenda regarding the innovation process by adopting IMS or want to align the development of IMS closer to the actual user needs in their respective EE.

Acknowledgements We thank the editor and the anonymous reviewers for their fruitful and constructive comments which helped to further improve the paper.

Funding Open Access funding enabled and organized by Projekt DEAL.

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